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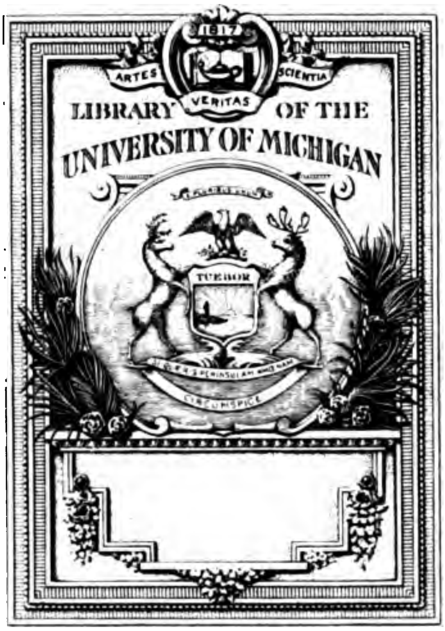
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illustrating both his own and Dr. Meyer's articles. The only cost to the State is for the printing of a few pages of ordinary letter-press.

In answer to the possible question as to what practical or economical value such work may have, it may be stated that there are at intervals through the Tertiary deposits of Alabama, ten or fifteen horizons at which occur beds of marine shells. In many cases these are closely associated with green-sands and other materials of economic value, the recognition of which becomes thus often a matter of importance.

The association of the shells in these marine deposits is always such that the different beds may in general be very easily identified and distinguished from each other by any one even moderately well acquainted with their fossil contents.

These shells thus become most valuable guides by which the geologist is enabled to recognize the identity of strata widely separated geographically, and differing widely in the character of the materials of which they are composed.

With the small appropriation available for the purpose of the survey, I should have hesitated to expend any of it upon a subject like this, which, while it has, as above shown, very important practical and economical bearings, might yet be looked upon as of comparatively little utility to the majority of the people of the State; therefore, our thanks are due to Mr. Aldrich for coming to our aid, both as a writer and financially.

EUGENE A. SMITH.

UNIVERSITY OF ALABAMA, *July* 1, 1886.

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INTRODUCTION.

Summary of the Lithological and Stratigraphical Features and Subdivisions of the Tertiary of Alabama.

In the Report of the Geological Survey of Alabama for the years 1883–'4, these relations of the Tertiary Formation are described in detail and fully illustrated by plates of sections and a map. From this report the following summary is taken.

THICKNESS.

The whole thickness of the strata of the Tertiary Formation of Alabama, occurring in the vicinity of the two rivers, is between 1620 and 1700 feet. This estimate is based upon actual measurements, except at one or two horizons, and even in these places we are able to give close estimates of the thickness of the strata not measured.

SUBDIVISIONS.

We have adopted a fourfold division of the Tertiary, which, in descending order, is the following:

1. The White Limestone,
2. The Claiborne,
3. The Buhrstone and
4. The Lignitic.

In all that follows the strata are described in descending order.

1. *The White Limestone.*—This subdivision is calcareous throughout, but the lowermost 60 feet are more argillaceous than the rest. The

minimum thickness is 350 feet, of which the uppermost 150 feet consist of a tolerably pure but somewhat silicious Limestone, filled with masses of coral.

The next succeeding 150 feet are made up of a soft white Limestone, often quite pure and filled with *Orbitoides Mantelli.* The lowermost 60 feet are of impure argillaceous Limestone, which, in disintegrating, yields a black calcareous soil similar to that derived from the rotten Limestone of the Cretaceous. This lower portion of the White Limestone surpasses the others in the variety of its fossils, and most of the forms described in this bulletin from the White Limestone come from this horizon.

2. *The Claiborne.*—The thickness is 140 to 145 feet, and the materials, sands and clays, which are generally calcareous and often glauconitic. Near the top of the subdivision is a bed of glauconitic sand 15 to 17 feet in thickness, filled with shells in perfect state of preservation. The sandy clays forming the lowermost 50 feet are likewise filled with a great variety of shells in good state of preservation. The intervening calcareous clays and calcareous sands are distinguished by the great numbers of shells of *Ostrea sellæformis* which they hold, as well as by the comparative rarity of other forms.

In view of the importance of this subdivision, I give below a more detailed section of the Claiborne Bluff and of the Lisbon Bluff, which is stratigraphically the continuation of the Claiborne Bluff.

This section, which was made jointly by Mr. Aldrich and myself, was first published by Mr. Aldrich in the *American Journal of Science,* October, 1885. In the Geological Report for 1883–'4 substantially the same section is given, but I shall here retain the numbers and letters by which the several beds are distinguished in the section published by Mr. Aldrich, as the references given in this Bulletin are generally to this particular section.

Section of the Bluff at Claiborne.

Drift	40 ft.
D. White Limestone bed containing Scutella and casts of shells. Zeuglodon bones found in this bed.—Hale, *American Journal of Science,* 1848, p. 361.	45 ft.
C. Scutella bed. *S. Lyelli* in great numbers	3 ft.
B. Coarse ferruginous sands, indurated at bottom	6 ft.
A. Claiborne fossiliferous sand; source of most of the Claiborne shells; thin layers of lignite about 10 feet down from top.	17 ft.
1. Indurated glauconitic sandy ledge.	4 ft.
2. Calcareous clayey strata, becoming sandy in lower part	18 ft.

3. Indurated sandy ledge..1 ft. 6 in.

4. Calcareous clay, sandy at bottom ....5 ft.

5. Light yellowish-gray calcareous sand, lower part indurated, containing casts of shells..5 ft.

6. Light yellowish-gray calcareous sands, containing *O. sellæformis*, Con.; *Scutella Lyelli*, in fragments; *Scalpellum Eocense*, Meyer; *Pecten Deshayesii*, Lea; *Pecten scintillatus* (?), Con., etc. Shows indurated ledges in places..27 ft.

7. Layer of comminuted oyster shells..3 ft.

8. Dark blue sandy clay..2 ft.

9. Bluish green clayey sands, very few fossils in upper part, crowded below, a large number of fossils distorted by pressure. *O. sellæformis*, Con.; *Venericardia rotunda*, Lea; *Nucula magnifica*, Lea; *Arca rhomboidella*, Lea; *Anomia n. sp. Amphidesma linosa*, Con., and many other bivalves..10 to 15 ft.

10. Dark bluish-green sand, containing a peculiar small form of *Vener. planicosta*, Lam.; *Turritella Mortoni*, Con.; *Turritella n. sp.*, *Crassatella, sp.*, *Corbula. sp.*, many bivalves..6 ft.

The Section at Lisbon is as follows, and Nos. 1 and 2 are equivalent to Nos. 9 and 10 of the preceding.

Section at Lisbon.

1. Brown, sandy strata, badly weathered, few fossils. .... 10 ft.

2. Sandy clays, dark brown, badly weathered also, but highly fossiliferous; contain the same fossils as Beds Nos. 9 and 10, at Claiborne, such as the following: *Amphidesma linosa*, *Arca rhomboidella*, *Turritella n. sp.*, *V. planicosta*, the peculiar, small variety; *V. rotunda*, *Lucina compressa*, *Ancillopsis vetustus*, *Rostellaria Whitfieldi*, Heilpr, etc., 12 ft.

3. Hard, sandy ledge..8 in.

4. Calcareous, clayey sands, light yellow when wet, nearly white when dry..6 to 8 ft.

5. Coarse-grained, ferruginous sands, fossils numerous ....3 ft.

6 and 7. Light yellow sand, with hard ledge on top; lower five feet dark blue when wet..20 ft.

8. Bluish-black clays; first of the *Buhrstone* ....8 ft.

3. *The Buhrstone.*—Minimum thickness 300 feet, the materials almost altogether aluminous and silicious, consisting of aluminous sandstones, claystones and quartzose sandstones, with occasional thin beds of glauconitic sands.

The few fossils which have been obtained from this division are mostly in the form of casts. They do not appear to differ specifically from those of the overlying division.

4. *The Lignitic.*—This is the most massive of the subdivisions of the Tertiary, having a thickness which can hardly be less than 900 feet. It also presents a greater variety in mineral composition, as well as in fossils, than the other divisions. In the most general terms, the Lignitic strata are cross-bedded sands, thin-bedded or laminated sands, laminated clays and clayey sands, and beds of Lignite as well as Lignitic matter, which merely colors the sands and clays.

With these are interbedded, at several horizons, strata containing marine fossils. For the sake of greater convenience and clearness of description, we present the Lignitic in *seven sections*, each of which includes, and is characterized by, one or more beds of marine fossils. These sections are as follows:

1. *The Hatchetigbee Section.*—175 feet in thickness; made up of sandy clays of prevailing brown or purplish color, containing three or four beds of marine fossils in the upper 75 feet, and of somewhat similar purplish-brown, sandy clays, nearly devoid of marine fossils, in the lower 100 feet.

All these brown, sandy clays become much lighter colored upon drying and exposure to the weather.

The following is a more detailed

Section at Hatchetigbee Bluff.

1. Light-colored, aluminous rocks, lowermost of the Buhrstone. ....20 to 30 ft.
2. Sandy clays of brown, yellowish and reddish colors interstratified... ....15 to 20 ft.
3. Heavy-bedded, dark-brown clays (similar to 2), but of darker color when dry.. ....10 ft.
4. Yellowish, glauconitic marl (marine shells)..................2 to 3 ft.
5. Purplish-brown, sandy clays, in the middle of which is a projecting ledge of dark-colored clays, which are harder, but which break up into small prismatic fragments upon weathering.................................15 ft.
6. Yellowish-gray sands, striped with thin streaks of brown, sandy clay, indurated in places ....5 to 6 ft.
7. Bluish-brown, sandy-clay marl, containing many new forms of shells ....5 to 6 ft.
8. Laminated, grayish sands, interstratified with thin beds of brown or black lignitic clay, indurated in places.......................................4 ft.

9. Heavy-bedded, gray, sandy clays, with streaks of brown colored clays ....8 ft.

10. Reddish, sandy marl, highly fossiliferous, forming concretionary bowlders. Remarkable for the great number of *Venericardia planicosta*, but containing also many other forms, such as *Athleta Tuomeyi*, *Fusus pagodiformis*, etc...4 to 5 ft.

11. Dark-gray to brown, sandy clays to water's edge..............15 ft.

2. *The Wood's Bluff or Bashi Section.*—80 to 85 feet in thickness. The uppermost 30 feet of this section consist of dark-brown clays passing into a green sand, which holds a great variety of finely-preserved marine shells. Below this green-sand marl are gray, sandy clays, with four or five thin beds of lignite within the first 25 feet, succeeded by about 30 feet of cross-bedded sands, with a two-feet seam of lignite at the base.

The details of the most important fossiliferous beds of this section, occurring at the typical locality, are given in the following:

Section at Wood's Bluff.

Orange sand or stratified drift; surface...............................20 ft.

1. Dark-brown or bluish-black laminated clays, forming the lowermost beds of the Hatchetigbee Section...10 ft.

2. Dark-bluish, sandy clays, turning red on exposed surface. This bed is highly fossiliferous, containing *Laevibuccinum striatum*, *Athleta Tuomeyi*, *Fusus pagodiformis*, and many other forms, some of which seem to be confined to this horizon.......................................3 to 4 ft.

3. Bluish, laminated clay, or sandy clay, much like No. 2 in color and texture, but containing no fossils, or very few, and not turning red on exposed surface; of variable thickness...............................5 to 8 ft.

4. Bluish or greenish sandy clay, somewhat indurated, of decidedly reddish color on surface; highly fossiliferous; characterized by *Turritellas* and *Dentalum microstriatum*, but containing also *Ancillaria staminea*, *Pyrula multangulata*, *Corbula oniscus*, *Infundibulum trochiformis*, etc. The lower part of this bed passes gradually into the green-sand marl No. 5, and is the best collecting ground, as the material is less indurated and the shells more easily removed. Thickness ....3 to 4 ft.

5. Green-sand marl, 10 to 12 feet down to the water level. The upper part of the marl is quite soft and friable, but just above the water's edge it becomes indurated, forming rounded bowlderlike masses. This and the preceding might together be considered as one, and called the *lower marl*.

3. *The Bell's Landing Section.*—This is 140 feet in thickness, and includes two important marine beds, and a third quite small and apparently unimportant. These fossiliferous beds are interstratified with yellowish sands in the upper, and rather heavy-bedded sandy clays in the lower, part of the section. The upper marine bed, called the *Bell's Landing Marl,* is about 10 feet in thickness, and has 40 feet of sandy strata above it. The middle bed is called the *Gregg's Landing Marl,* and it lies 20 to 25 feet below the preceding, from which it is separated by dark-gray, sandy clays. This bed is some five or six feet in thickness, and the upper part of it is seen near the water level at Bell's Landing, while the whole bed is well shown at several points higher up the river, notably at Gregg's Landing, Peebles' Landing and Lower Peach Tree. The lowermost of the fossiliferous beds of this section is only about one foot in thickness, and it lies about 50 feet below the Gregg's Landing bed, being separated from it by sandy clays. It is highly glauconitic, but does not contain any great variety of fossils. It has been observed only at Lower Peach Tree. The Bell's Landing Marl is distinguished from all others in Alabama by the great size of the shells which it holds. This bed is seen at the typical locality, Bell's Landing; at Peebles' Landing, at Gregg's Landing, at Lower Peach Tree and at Yellow Bluff on the Alabama, and at Tuscahoma, Turner's Ferry and Barney's Upper Landing on the Tombigbee River.

4. *The Nanafalia and Coal Bluff Section* —The strata of this section are 200 feet in thickness, and consist of about 50 feet of gray, sandy clays at top, which show a great tendency to indurate into tolerably firm rocks, resembling very closely some of the strata of the Buhrstone. Below this, about 80 feet of sandy beds, often strongly glauconitic, characterized throughout by the presence of small oysters, *Gryphæa thirsæ.*

Near the base of this sandy division there is a bed about 20 feet thick, literally packed with these shells.

Below the *Gryphæa thirsæ* beds follow some 70 feet of cross-bedded sands, glauconitic, and apparently devoid of fossils, including, about 10 feet from the base of the section, a bed of lignite which varies in thickness from four to seven feet.

The greatest variety in the shells of this group is seen in the strata which immediately underlie the lowest of the beds containing *Gryphæa thirsæ,* and the following section of the type locality is therefore given :

Section at Nanafalia Landing.

1. Green-sand marl, highly fossiliferous, the main form being *Gryphæa thirsæ*, with a few other shells, such as *Turritella Mortoni*, a *Flabellum*, etc. This is the lowermost of the Gryphæa beds, and is here about 20 feet thick.

2. Dark-blue, almost black, laminated clay, devoid of fossils, but passing below gradually into a bluish marl. .... 3 to 4 ft.

3. Bluish, green-sand marl, containing a few shells in the upper three or four feet, but becoming much more fossiliferous below. This bed contains a great variety of beautifully preserved and easily detached fossils, which can, however, be seen only at a low stage of water. Thickness. ....8 to 10 ft.

5. *The Naheola and Matthews' Landing Section.*—It is difficult to give the thickness of the strata of this section, since it varies on the two rivers. We have placed it at 130 to 150 feet. The strata are gray, sandy clays in the main, alternating with cross-bedded sands. The beds of dark, sandy clay containing the marine shells lie at the base of the section; but the Naheola bed on the Tombigbee, while occupying a similar stratigraphical position to the Matthews' Landing bed on the Alabama, differs from it in the character of the materials as well as in the fossils. The two have not been seen so near together as to enable us to determine their relative position.

The following details are given of the

Section at Matthews' Landing.

1. Bluish-black, micaceous, clayey sand, with finely preserved fossils. Very dark when wet, but becoming grayish blue on drying. Crumbles upon exposed slopes, liberating the fossils, which lie in the crumbs thus produced. This is capped by an indurated, sandy, concretionary ledge. Thickness of the fossiliferous strata about.................................5 or 6 ft.

2. Gray sands with slightly yellowish cast, showing a tendency to indurate into lens-shaped bowlders one to two feet thick and three to four feet wide. These sands are also fossiliferous, but much less so than the preceding beds; the fossils are difficult to get out because of the hardness of the material...3 to 4 ft.

3. Bluish, micaceous, clayey sand, much like No. 1, but not holding all of its characteristic fossils. Where this stratum lies exposed to the sun and weather upon flat or nearly horizontal benches, it disintegrates, like No. 1, into crumbs, in which the liberated fossils lie loosely; but

where it forms vertical bluffs, it is firm and compact and resembles black clay. Thickness about... ....7 or 8 ft.

6. *The Black Bluff Section.*—Here, again, we have difficulty in determining the exact thickness, since, on the Tombigbee, the strata of this section are spread over an extent of surface which would, with uniform dip, correspond to a thickness of over 200 feet, while, on the Alabama, and more particularly inland, in the eastern part of Wilcox County, the thickness is not greater than 35 to 40 feet. Since 80 feet of these beds are seen in superposition at one locality (Black Bluff), we think that the maximum can not be less than 100 feet.

The characteristic strata which compose nearly the whole of this section are black or very dark-brown clays, which are in part fossiliferous. A detailed section would present nothing of importance for our present purpose.

7. *The Midway or Pine Barren Section.*—Thickness 25 feet. The strata are a white, argillaceous limestone, holding a large *nautilus*, which is characteristic of the horizon, 10 feet thick; followed by calcareous sands and a yellowish, crystalline limestone, with *turritellas*, *carditas* and *corals*—the sands six feet, the limestone eight or nine feet. This section is best seen in eastern Wilcox County, on Pine Barren Creek; but the upper or nautilus-bearing rocks occur at Midway, on the Alabama River, and westward across Marengo County. No exposure of these rocks has been observed on the Tombigbee River, but they will probably be found a short distance below Moscow.

I.

PRELIMINARY REPORT

UPON THE

Tertiary Fossils of Alabama and Mississippi.

BY

T. H. ALDRICH.

DR. EUGENE A. SMITH,
State Geologist, University, Alabama.

Dear Sir:—The inclosed report consists of a list of the fossils procured by your survey in Alabama, their distribution, with descriptions of part of those believed to be new, also of others collected in Mississippi, and one new species from the Jackson Group of Louisiana. There are added twenty previously described fossils from Alabama and Mississippi, which are all likely to be found in your State.

At my request Dr. Otto Meyer has added in a separate paper a large number of new species obtained by him partly from the Claiborne Sand, and in the Jackson and Vicksburg Groups in Mississippi.

Very Respectfully,
T. H. ALDRICH.

BLOCTON, BIBB COUNTY, ALABAMA, *June* 13, 1886.

PREFACE.

The present condition of the paleontology of the Tertiary Formation is so much confused that it has been found quite impossible to make a complete and accurate report at this time; therefore, simply as a beginning, the writer has prepared the following descriptions and lists.

No attempt has been made to correct the nomenclature; in general, the name under which a species has been described, is used, sometimes that of Conrad, and often that of Lea, without attempting to decide questions of priority.

Again, many species are described without figures, and in others the descriptions are so vague or figures so poor, it has been found out of question to identify from them alone. The writer hopes to correct, as far as possible from the types these uncertainties, and in a final report to bring the subject up to date. In these tables or lists where a species could not be definitely ascertained, no specific name is given; where the identification is at all doubtful, the specific name is followed by a question mark, and where a species is believed to be new, it is so indicated.

At present the collections in hand have not been sufficiently examined to report upon the Claiborne ferruginous sand-bed proper, the Jackson and Vicksburg Groups. These are reserved for the future.

Plates 1 and 2 were published in the Journal of the Cincinnati Society of Natural History, Vol. VIII., July, 1885, but as several changes are necessary, they are inserted here.

The writer is greatly indebted to Prof. Angelo Heilprin, of Philadelphia Academy of Natural Sciences; Prof. R. P. Whitfield, of the American Museum, New York; and Dr. Otto Meyer for identifications and critical remarks. To Dr. C. A. White, of the U. S. Geological Survey for the loan of types; and more especially to Dr. Eugene A. Smith for the opportunity to make the collections from which this paper is prepared.

PART I.

Notes and Descriptions of Species.

In univalves herein described, the term "longitudinal" is understood to be from apex to canal and "transverse' at right angles to this direction. The figures are all either natural size or the true dimensions are indicated with each.

GASTROPODA.

MUREX ANGELUS, Aldr. Pl. 2, fig. 2.

Murex angelus, Aldr. J. C. S. N. H., July, 1885, p. 145. Pl. 2, fig. 2.

MUREX MATTHEWSENSIS, n. sp. Pl. 3, fig. 15.

Shell triangular, whorls probably four; angular, smooth between the varices; varices three, longitudinal, prominent; spines of the body whorl elongated and curved upward, the one at the angle of the aperture nearly closed; body whorl angulated on upper part, the other whorls rounded; aperture ovate, outer lip thick with a foliation at the junction with the body whorl running from the spine to the beak; inner lip smooth with a slight lamina; beak short; canal rather wide.

Locality.—Matthews' Landing, Ala.

Differs from *M. morulus*, Con., in having no spines between the varices at the shoulder of the body whorl, and has no crenulations on the edge of the outer lip.

MUREX SIMPLEX, n. sp. Pl. 5, fig. 8.

Shell short, stout; whorls probably five; suture deeply impressed; varices numerous, very large and broadly rounded, terminating above near the suture in sharp points; seven on the body whorl, numerous coarse raised revolving lines cover the whorls; aperture small, elliptical, terminating anteriorly in a nearly closed canal; outer lip thickened and crenate within; three folds appear upon the columella.

Locality.—Bryan's Ferry, Miss.; Vicksburg Group.

This type specimen has retained its former apertures, which give to the shell a broad termination and a false umbilicus.

TROPHON GRACILIS, n. sp. Pl. 5, fig. 6.

Shell acuminate, whorls, ten, rounded; spine high, with three embryonic whorls, the first two smooth, the next showing longitudinal varices, the balance with numerous (in the type nine) strong varices, which are, when perfect, thin, fringing and sigmoid; six or more revolving lines cut the edge of the varices into an equal number of crenulations, these revolving lines being strongest at their intersecting points; aperture ovate, terminating in a narrow canal which turns strongly to the left and slightly upward; outer lip sharp, thickened and crenulated within; three slight protuberances on the anterior part of the columella near the canal.

Locality.—Lower Bed, Wood's Bluff, Ala.

Only two specimens found. This species is more acuminate and has a shorter canal than is usual in living forms.

TROPHON CAUDATOIDES, n. sp. Pl. 6, fig. 4.

Shell with numerous varices; whorls seven, uppermost two smooth, the others angulated by the variceal nodes and crossed by a few revolving lines, which are rather coarse and somewhat alternate; one to four thickened lamelliform varices on different specimens at irregular distances apart. Aperture ovate; outer lip expanded and crenate within; columella smooth, twisted below; canal rather abruptly turned to the left.

Locality.—Hatchetigbee Bluff, Ala.

PSEUDOLIVA UNICARINATA, n. sp. Pl. 5, fig. 17.

Shell broadly ovate, whorls seven, sutural line wavy; spine sharp, the upper part rising suddenly from the flattened body whorl; nucleus composed of three smooth embryonic whorls. Body whorl shouldered, bearing large longitudinal ribs pointed at the angle, extending nearly to the sulcus below, above reaching to the suture, where they abruptly turn to the left and form rather deep pits betwen them. The carina of the body whorl has a raised line connecting the pointed part of the tuberculations; all the whorls below the nucleus show the tuberculations; sulcus rather deep. No umbilicus; entire surface covered with very fine revolving lines.

Locality.—Matthews' Landing, Ala.

Nearest to *Pseudoliva tuberculifera* Con.; but that species has strong revolving lines; its tubercles are lower down on the body whorl, not sharp; the sutural part is entirely different, and the shell is besides much more fusiform.

The pits above mentioned are very small on young specimens, and are not shown in the figure.

PSEUDOLIVA SCALINA, Heilpr. Pl. 6, fig. 10.

Pseudoliva scalina, Heilpr. P. A. N. S., p. 371. Pl. 20, fig. 12, 1880.

The figures given by Prof. Heilprin do not give a clear idea of this species. Our figure is from the type, and has been redrawn by Dr. Otto Meyer. The original, now in the University Cabinet at Tuscaloosa, Ala., is from Wood's Bluff, Ala.. and is extremely rare there.

At Bell's Landing, on the Alabama River, it occurs of gigantic dimensions. The largest specimen in the University Cabinet is $4\frac{8}{10}$ inches long, and $2\frac{7}{10}$ inches wide. The transverse lines are dim from wear, the tuberculations are strongly curved to the right, the plaits on top rise up to the suture of the succeeding whorl abruptly from the shoulder and are bent to the left.

Very close to *Pseudoliva robusta* Briart et Cornet, from the Calcaire Grossier de Mons, France.

TRITON (SIMPULUM) CONRADIANUS, Aldr. Pl. 2, fig. 8.

Triton (*Simpulum*) *Conradianus*, Aldr. J. C. S. N. H., July, 1885, p. 148. Pl. 2, fig. 8.

Very common in Eastern Mississippi, in the Red Bluff Strata.

RANELLA (ARGOBUCCINUM) TUOMEYI, n. sp. Pl. 3, fig. 3.

Shell oblong-ovate, canal strongly recurved, bent upward; whorls seven; spire elevated, pointed, the first two whorls smooth, the others cancellated, the longitudinal lines forming tubercles at intersections; tubercles sharp, transverse, strongly developed on the periphery of the body whorl and next one above, generally three large ones on the body whorl between the varices; transverse striæ numerous, composed of coarse lines, having three finer ones between, and others between these; line of growth fine; varices strong, pitted on the back side; suture impressed, slightly shouldered; aperture ovate; outer lip with a strong varix, nine tubercles within, canal nearly as long as the aperture.

Locality.—Lower bed, Woods' Bluff, Ala.

Young shells show more tubercles between the varices than the type. Named in honor of the late Prof. Michael Tuomey.

FUSUS PEARLENSIS, Aldr. Pl. 1, fig. 17 a, 17 b.

Fusus Pearlensis, Aldr. J. C. S. N. H., July, 1885.

Fusus Boettgeri, Meyer. *Am. Jour. of Science*, June, 1885. (Name preoccupied.)

This species has been found to be quite variable.

FUSUS MEYERI, Aldr., n. sp. Pl. 3, fig. 12.

Shell elongate fusiform; spire slender, acute; whorls fourteen; surface of the spire and body whorl with seven longitudinal broadly rounded folds, which are spirally arranged, crossed by raised rounded striæ, generally seven in number, rather distant, the central one making a sharp carina on the center of each whorl, with erect longitudinal tubercules at the intersections; spaces between striæ showing only lines of growth; canal very long, spirally striated with alternate raised lines; lines of growth very numerous and almost obsolete; mouth small, oblong-ovate; outer lip incurved, smooth.

Locality.—Lower bed, Woods' Bluff, Ala.; Matthews' Landing, Ala.

The figured type retains four embryonic whorls; three are smooth, the fourth longitudinally striate. The Matthews' Landing form is smaller and even more beautiful. One specimen has the ribs obsolete on the upper half of the whorls and the periphery armed with erect longitudinal spines, giving the shell a very strongly carinate form. *Fusus Mississippiensis*, Con., from Vicksburg, resembles this form, but this is more carinate, with longer canal and spire; the latter species has many more revolving lines, and the outer lip is striate internally. Named in honor of Dr. Otto Meyer.

FUSUS TOMBIGBEENSIS, n. sp. Pl. 5, fig. 7.

Shell fusiform; whorls nine, rounded; spire high, apex composed of three embryonic whorls—first two smooth, the next longitudinally ribbed, balance with about ten rounded ribs, somewhat alternating at the suture, strongest on the center of each whorl; whorls crossed by raised rounded lines, alternate in size and nearly equidistant; aperture oblong-ovate; outer lip crenate within; canal short, straight, rather open.

Locality.—Woods' Bluff, Ala.; lower bed.

The type specimen has unfortunately lost its canal, but a younger specimen supplied thè description. Younger specimens have the whorls more carinated than in the figured type.

FUSUS RUGATUS, n. sp. Pl. 5, fig. 9.

Shell fusiform, spire high, suture linear; whorls carinated, concave and smooth above, rounded below, the periphery of each whorl with numerous tubercles, some of them reaching to a second revolving raised line below; the whorl next above the body whorl showing two tuberculated lines below the carina; body whorl showing four rows of spinous lines, contracted rather abruptly below them; canal covered with distant spiral rows of sharp spines; aperture small, angulated posteriorly, terminating in a long, narrow canal.

Locality.—Gregg's Landing, Ala.

The type specimen is broken, but other specimens likewise broken show a long, narrow canal spirally striated to the end.

FASCIOLARIA JACKSONENSIS, Aldr. Pl. 2, fig. 12.

Fasciolaria Jacksonensis, Aldr. J. C. S. N. H., July, 1885.

Dr. O. Meyer considers this species identical with his *Turbinella humilior, American Journal of Science,* June, 1885, which he now places in the genus *Latirus.* Whether the remarks in his paper constitute a prior description I leave for others to decide.

FASCIOLARIA PERGRACILIS, n. sp. Pl. 5, fig. 18.

Shell narrowly fusiform; spire very slender; suture impressed; whorls thirteen—nucleus composed of three smooth ones, the following seven are longitudinally ribbed, balance nearly smooth; two equidistant revolving grooves (the one nearest the suture the largest) border it throughout.

Canal long, spirally striated; outer lip smooth; columella bearing posteriorly three faint oblique plaits far within the aperture.

Locality.—Gregg's Landing, Ala.

Decidely fusiform in aspect.

LEUCOZONIA BIPLICATA, n. sp. Pl. 5, fig. 15.

Shell broadly fusiform; whorls six—nucleus composed of two smooth whorls, those remaining covered with revolving, somewhat alternating raised lines and strong longitudinal ribs, which give the shell an angular appearance. Outer lip sinuate, thickened internally, finely crenated; columella bearing two erect, strong folds, the posterior one nearly twice as large as the other, below these folds nearly straight.

Aperture terminating in a short, open canal. A small umbilicus nearly covered by callus.

Locality.—Matthews' Landing, Ala.

BULBIFUSUS PLENUS, n. sp. Pl. 6, fig. 7.

Shell broadly fusiform; whorls probably six, surface on upper whorls with a few distinct revolving lines, which on the upper part of the body whorl become faint; body whorl swollen above, rapidly narrowing below, where it is spirally striated with alternate raised lines; whorls thickened and constricted at suture and suddenly rounded; suture hidden in the groove thus formed; surface finely marked with lines of growth; aperture oblong-ovate, terminating in a rather broad canal, which turned to the left; outer lip slightly crenate within; columella smooth, no perceptible callus on posterior part.

Locality.—Bell's Landing, Ala.

Resembles somewhat the Jacksonian species of *Clavella*, but its whorls are few, spire low and canal recurved. The apex is worn, but appears to be blunt.

BULBIFUSUS INAURATUS, Con. Pl. 6, fig. 11.

Fusus inauratus, Con. Foss. Shells of Tert., p. 29.
Fusus Fittoni, Lea. Cont. to Geol., p. 150. Pl. 5, fig. 156.
Bulbifusus inauratus, Con. Cat., 1865.

Figured to show its similarity to the species described below.

BULBIFUSUS TUOMEYI, n. sp. Pl. 6, figs. 12, 12 a.

Shell large, bulbiform; whorls seven; spire moderate; body whorl very large and globose, flattened above and slightly concave, contracted below and finely striated; aperture oblong-ovate; outer lip smooth within; columella strongly excavated, canal wide and curved.

Locality.—Bell's Landing, Ala.

This species may only be a strongly marked variety of *B. inauratus*, Con., mentioned above, but the younger specimen (12 a) from Gregg's Landing differs from Conrad's species in having finely revolving lines over its whole surface, whorls convex, closely appressed at the suture, while the other has the whorls concave, the lines obsolete on the central part of body whorl, is shouldered at the suture, which is in a groove, and generally has the first four whorls of the spire with a row of revolving nodes above the suture.

NEPTUNEA ENTEROGRAMMA, Gabb. Pl. 3, fig. 5.

Neptunea enterogramma, Gabb. J. A. N. S., Phila. Vol. IV., 2d ser., 1860, p. 378, pl. 67, fig. 14.

This species described from Texas is not uncommon at Lisbon. Gabb's type was a young shell. The two forms are connected by a series in my possession.

NEPTUNEA CONSTRICTA, n. sp. Pl. 5, fig. 13.

Shell broadly fusiform, whorls eight, spire high; suture distinct, whorls concave and compressed just below the suture; covered at this point with fine transverse lines, remaining space smooth. Body whorl large, smooth below the above-mentioned sutural area, narrowed below into a short, stout canal which is marked by fine revolving lines. Aperture about two-thirds the length of shell; outer lip sharp, thickened and crenulate within; inner lip concave above, straight below; callus not heavy.

Locality.—Matthews' Landing, Ala.

This species differs from the previous one mentioned, by its compressed space below the suture and absence of a sutural groove.

FULGUR TRISERIALIS, Whitf. Pl. 1, fig. 23 b.

Pyrula Smithii, Sowb. Aldr. in J. C. S. N. H., July, 1885.

Fulgur triserialis, Whitf. *Am. Jour. Conch.*, 1865, vol. I., p. 260.

On first finding this shell it was supposed to be *Pyrula Smithii*, Sowb., but a comparison since made leads me to consider it distinct. On submitting specimens to Prof. Chas. E. Beecher, at Albany, N. Y., he pronounced them identical with the type now in the cabinet of Prof. Hall.

PYRULA JUVENIS, Whitfield. Pl. 6, fig. 8.

Pyrula juvenis, Whitf. *Am. Jour. Conch.*, vol. I., 1865, p. 259.

Pyrula multangulata, Heilpr. P. A. N. S., 1880, p. 374, pl. 20, fig. 2.

Hitherto unfigured. Prof. Whitfield has kindly furnished me with a drawing of the type. Common in the lower Tertiary, Bell's Landing, Gregg's Landing, Nanafalia Group, Matthews' Landing and Woods' Bluff. It is subject to considerable variation, and is probably the same species quoted by Prof. Heilprin from Woods' Bluff, Ala., as *Pyrula tricostata*, Desh.

PYROPSIS PERULA, n. sp. Pl. 3. fig. 4.

Shell depressed above, spinous; whorls seven; spire flat, showing only the upper part of the whorls; suture partially concealed by the spines of the next succeeding whorl overlapping.

Surface covered with strong, transverse, raised, cordlike lines, which are armed with short, erect spines on the canal, becoming obsolete at its base. Spines erect, closed, flaring upward and circling the periphery of the body whorl, the one nearest the aperture being the largest. Aperture ovate; outer lip cut by the transverse lines, smooth within; labium strongly reflected, smooth, suddenly expanding at the anterior end of aperture; callus becomes thick in old specimens; canal long and narrow.

Locality.—Wood's Bluff, Ala., in lower bed; also Matthews' Landing, Ala.

The largest specimen, if perfect, would be (2″) two inches broad and over (4″) four inches long.

PISANIA? DUBIA, n. sp. Pl. 3, fig. 13.

Shell fusiform; whorls rounded, about eight in number; spire acute; surface covered with equidistant revolving lines, which are broadly rounded, the spaces between smooth.

Lines of growth obsolete; the embryonic whorls are smooth. Aperture oblong-ovate; canal moderate; outer lip thickened and striate within; inner lip smooth, slightly excavated, thickened and angular at junction with canal.

Locality.—Lower bed, Wood's Bluff.

The absence of a callosity at the posterior end of the aperture makes the generic place doubtful.

BUCCINUM MOHRI, n. sp. Pl. 3, fig. 16, a.

Shell rather solid; spire high; apex obtuse; whorls seven, rounded; suture rather shallow; surface smooth. Lines of growth coarse, showing on the body whorl. Outer lip strongly reflected, slightly shouldered at its junction with the body whorl. Aperture semi-lunate nearly two-thirds the length of the shell, smooth internally, terminating in a short, excised canal.

Locality.—Lisbon, Ala.

This species has some resemblance to *Buccinum stromboides*, Herm., from the Calcaire Grossier, of Grignon, but lacks the striations on the lower part of the body whorl, is less swollen in outline, and has a more strongly reflected outer lip. Named in honor of Dr. Chas. Mohr, of Mobile, Ala.

COMINELLA HATCHETIGBEENSIS, n. sp. Pl. 3, fig. 6, a. b.

Shell bucciniform, oblong-ovate; whorls shouldered, with a depressed groove at the suture. Spire short, smooth; apex obtuse. Body whorl strongly shouldered, contracted below, with numerous revolving lines on the basal portion, which are obsolete on the middle part; the center is flattened, sometimes concave. Aperture oblong-ovate; outer lip sinuous, with a distinct, rounded, semi-circular slit on the upper third below the shoulder, smooth internally; inner lip smooth, reflected, thickened above and below.

Locality.—Hatchetigbee Bluff. In two different horizons there.

This peculiar form has such a distinct slit in the outer lip (fig. 6), that it may deserve a subgeneric place, though it resembles the living *Cominella maculata*, Martyn, from New Zealand. In one specimen the shoulder of the body whorl rises so as to almost hide the succeeding whorl, giving the shell a triangular form.

COMINELLA STRIATA, n. sp. Pl. 5, fig. 4.

Shell ovate, fusiform; whorls five to six, with fine, transverse lines, shouldered. Suture in a depressed groove. Lines of growth sinuous, giving the shell rather a rough exterior. Body whorl contracted rapidly from the center toward the base. Striae coarser on the basal portion; spire about one-third the length of the shell; apex blunt; aperture oblong-ovate, smooth within. Columella broadly reflected; canal produced canaliculate at base.

Locality.—Hatchetigbee Bluff, Ala.

Differs from the previous species by being striate, its more produced spire and fusiform shape.

The outer tip is broken away, but the lines of growth indicate a semicircular slit, as in the former species.

PHOS VICKSBURGENSIS, Aldr. Pl. 2, fig. 9.

Buccinum Vicksburgensis, Aldr. J. C. S. N. S., July, 1885.

Changed to the genus *Phos*, Prof. Heilprin having indicated its proper place to me.

NASSA CALLI, n. sp. Pl. 5, fig. 5.

Shell oblong-ovate; spire elevated; whorls seven, shouldered, and rounded at suture, with a number of revolving lines just below central part of body whorl; smooth, with five or six striations on the base. Aperture oblong-ovate; labrum crenulate within; a strong fold on the columella at the anterior end of aperture, a number of crenulations above this within the opening.

A thick, well-defined callus spreading over the body whorl, thicker posteriorly.

Locality.—Lisbon, Ala.

Named in honor of my friend Prof. R. E. Call, of the State University, at Columbia, Mo.

TURBINELLA (CARICELLA) RETICULATA, Aldr. Pl. 2, fig. 4, a. b, c.

Turbinella (*Caricella*) *reticulata*, Aldr. J. C. S. N. H., July, 1885.

Since found in lower strata.

TURBINELLA BACULUS, n. sp. Pl. 6, fig. 2, a.

Shell robust, broadly fusiform; whorls five—two forming a nucleus, next two cancellated. Body whorl large and globose; revolving striae alternately coarse and fine, well marked, while the longitudinal ones on it become faint.

Aperture over half the length of the shell; outer lip smooth; columella with two nearly equal erect plaits; callus thin, spreading; canal short, open and recurved. No umbilicus.

Locality.—Bell's Landing, Ala.

A specimen in the State Collection is over twice as large as the type, but imperfect.

VOLUTA SHOWALTERI, n. sp. Pl. 3, fig. 14.

Shell oval, oblong; whorls five; spire blunted; surface smooth and shining; lines of growth hardly perceptible; suture moderately impressed.

Body whorl and next succeeding shouldered, bearing thereon numerous small tubercles; above the shoulder they are concave.

Aperture two-thirds the length of the shell; columella four plated—the upper one transverse, the middle ones oblique and larger. Outer lip smooth.

Locality.—Matthews' Landing, Ala.

This species is a true Volute, and belongs to the section *Vespertilio* Klein—Rare.

Named in honor of Dr. E. R. Showalter, of Point Clear, Ala.

MITRA HATCHETIGBEENSIS, n. sp. Pl. 6, fig. 3.

Narrow fusiform; whorls about ten; suture impressed; nucleus smooth; upper whorls longitudinally ribbed, carinate at their center and tuberculated; the body whorl slightly concave above, with transverse tubercles; whole surface covered with fine, revolving lines.

Aperture narrow nearly half the length of the shell; outer lip smooth; columella straight, with three nearly equal oblique plaits.

Locality.—Hatchetigbee Bluff, Ala.

ANCILLARIA EXPANSA, n. sp. Pl. 5, fig. 11.

Shell large, ovate, flattened above; whorls about seven, spire moderate; the youngest whorls encircled by a row of tubercles; suture impressed, covered with a thin callus. Upper whorls and the upper third of the body whorl flattened, then rather abruptly rounded and regularly diminishing toward the base, where it is bounded by a large basal groove.

Aperture oblong-ovate; outer lip thick, a callosity at the posterior; columella smooth, covered with callus, and somewhat twisted. No umbilicus; no sulcus visible.

Locality.—Lisbon, Ala.

Faint traces of revolving color lines remain.

EXPLERITOMA, nov. gen.

Shell rounded-elliptical; suture linear; whorls few; a small sulcus on the basal part of the body whorl; base canaliculate.

Aperture either filled in or contracted to half the original size by a thickened, circular peristome. Umbilicus generally covered by this deposit.

Has a general resemblance to the genus *Pterocheilos*, Moore, by reason of its peculiar aperture. This deposit or filling in is not accidental, as Dr. O. Meyer has, in his collection, a very young shell of similar form, either the same or an allied species, showing the same peculiarity. It is from the Claiborne sand-bed.

This young shell has the umbilicus exposed, but the aperture is even more filled in than my type specimen, and the spire is flattened. This genus would be next to *Ancillaria* in the *Ancillarinæ*.

Expleritoma prima, n. sp. Pl. 5, fig. 1.

Shell rounded-elliptical; surface probably smooth; spire moderate; whorls, four to six; a well defined but small sulcus upon the lower half of the body whorl; base canaliculate, but filled up with a deposit from the aperture.

Aperture elliptical, about one-half the indicated size, caused by a thick deposit covering the whole peristome, except a small space on the outer lip.

Locality.—Branch of Satilpa Creek, Ala., in ferruginous sand-bed of Claiborne Group.

Only one specimen found, and that is considerably eroded. The back of the shell looks like a specimen of *Ancillopsis subgloboſa*, Con.

Pleurotoma Heilprini, Aldr. Pl. 1, fig. 15.

Pleurotoma Heilprini, Aldr. J. C. S. N. H., July, 1885.

Pleurotoma Americana, Aldr. Pl. 1, fig. 16.

Triforis Americanus, Aldr. J. C. S. N. H., July, 1885.

Prof. Heilprin pronounces this species, which I described as a *Triforis*, to be a reversed *Pleurotoma*. While the lines showing the slit are not very apparent, yet, in deference to his opinion, the change is made. It is so different from most of the Triforis group, that it is much more likely to be nearer its true place than before. As the shell is quite common in Jackson, and always reversed, it is probably a good species.

Pleurotoma anita, Aldr. Pl. 2, fig. 3.

P. anita, Aldr. J. C. S. N. H., July, 1885.

PLEUROTOMA LONGIFORMA, Aldr. Pl. 2, fig. 10, a. b.

P. longiforma, Aldr. J. C. S. N. H., July, 1885.

PLEUROTOMA PEREXILIS, n. sp. Pl. 3, fig. 2.

Shell slender, acuminate: whorls eight, convex, surface covered by revolving lines, which in some places have finer ones between, especially on the lower half of the shell. Lines of growth faint, very distinct under a glass; suture bordered below by an impressed line; slit wide and shallow; aperture half the length of the shell.

Locality.—Moody's Branch, Jackson, Miss.

This species is exactly the shape and appearance of *Pleuro venusta*, Heilprin, but, on submitting the above specimen to Prof. Heilprin, he stated it to be distinct, as *P. venusta* has its revolving lines arranged in pairs. The type specimen belonged to the National Museum, but on sending our shell there it could not be found, so a comparison could not be made.

PLEUROTOMA EXILLOIDES, n. sp. Pl. 3, fig. 9.

Shell slender; spire high; whorls ten, rounded, slightly shouldered below the suture; a rather strong impressed line just below, with fainter ones still lower.

The first four or five whorls of the apex smooth, the others transversely striate, striations very closely set on the body whorl. Slit nearly semicircular; outer lip gently curved; columella bent; canal short, curved to the right.

Locality.—Lower bed, Wood's Bluff, Ala.

This species is close to *P. perexilis*, above described, but differs in the breadth of the body whorl, and the slight shouldering of the same. The slit is larger, and the revolving lines much fainter.

PLEUROTOMA TOMBIGBEENSIS, n. sp. Pl. 3, fig. 10.

Shell large, rather thick and solid, fusiform; whorls eleven; suture impressed; the spire regularly acuminate; the upper whorls flattened; lower ones constricted below the suture.

Body whorl constricted about the center, tapering regularly toward the beak; a large number of fine sinuous revolving lines upon this lower part.

Aperture less than half the length of the shell; slit small, situated at the lower part of the sutural constriction, its outer edge rising up and rounded; canal moderate, open, bent a little to the right; columella with a reflected callus near the the beak.

Locality.—Lower bed, Wood's Bluff, Ala.

On younger specimens the constriction below the suture is obsolete, being replaced by a few faint revolving lines. Resembles *P. longiforma nobis*, but in some respects differs. It is much more fusiform, heavier, the body whorl much more tapering below. The aperture gradually diminishes anteriorly, while in the first-mentioned species, and in P. Gabbi, Con., the canal is long and slender.

PLEUROTOMA TUOMEYI, n. sp. Pl. 3, fig. 11.

Shell narrow, fusiform; spire high; whorls twelve, the first three rounded and smooth, next with revolving lines, and the balance strongly carinated with two or more revolving lines some distance apart, with numerous fine ones between, these last alternate. Suture bounded below by a fine raised line; surface, from first carination to suture, concave, showing exceedingly fine but distinct lines of growth, which spread over the whole shell.

Body whorl with two strong raised carina, the upper one sometimes double, with lesser lines below, alternating with a number of finer ones. Slit narrow, deep and rounded, situated between the raised sutural line and the first carination. Aperture oblong, narrow, terminating in a long, straight canal; beak slightly turned to the left.

Locality.—Lower bed, Wood's Bluff, Ala.

The largest specimen measured 1$\frac{8}{10}$″ in length—a beautifully ornamented shell, quite rare. Prof. Michael Tuomey was the first to visit this locality, where so many of these new species come from.

PLEUROTOMA (ANCISTROSYRINX) COLUMBARIA, n. sp. Pl. 6, fig. 9.

Shell small, fusiform; whorls ten; the nucleus smooth, composed of three whorls; the remaining seven shouldered, and armed with erect spines rising above the edge of the shoulder, giving to the shell a pagoda form; upper part of whorls smooth, concave, with a faint broken line just below the suture, composed of longitudinal striæ; lower part of the whorls with nine or ten coarse alternate revolving rows of rounded tubercles, which extend over the spines. Slit rather large, semicircular.

Locality.—Dry Creek, Jackson, Miss.

The body whorl is broken away, rendering it impossible to complete the description. Closely resembles *Fusus pagoda*, Lesson, a living Philippine Island shell. Having submitted this specimen to Prof. Dall, he pronounces it a good species, and belonging to the group *Ancistrosyrinx*, instituted by him, characterized by a sharp nucleus, and having the last whorl keeled.

CONUS (CONORBIS) ALATOIDEUS, Aldr. Pl. 2, fig. 11.

C. alatoideus, Aldr. J. C. S. N. H., July, 1885.

STROMBUS SMITHII, Aldr. Pl. 2, fig. 6.

S. Smithii, Aldr. J. C. S. N. H., July, 1885.

APHORAIS GRACILIS, n. sp. Pl. 5, fig. 14.

Shell fusiform, whorls eight, spire high; embryonic whorls smooth, the others to the body whorl with longitudinal ribs which curve to the left into the suture and are crossed by fine revolving lines; body whorl expanded into a broad outer lip, furnished with two digitations, the posterior one the largest, rising in some specimens into a long, sharp point, strongly grooved to the apex. The outer lip extends up the spire to the top of the body whorl only; the groove in the anterior digitation rather faint; surface of body whorl with two revolving carina marking these grooves and covered with faint revolving lines; aperture small, inner lip with a spreading callus; canal moderate, terminating in a sharp point slightly recurved.

Locality.—Gregg's Landing, Ala.

Quite common; the digitations are subject to considerable variation, the younger forms have only the posterior one.

The embryonic apex is missing in every specimen. One example has made a double outer lip; the posterior digitations lying over each other and distinct; the anterior ones coalescent.

CYPRÆA SPHEROIDES, Con. J. A. N. S., 2d ser., p. 113. Pl. 11, fig. 6.

A young specimen of this Vicksburg form is in my collection from the Claiborne Sand.

CYPRÆA LINTEA, Con. Pl. 5, fig. 2.

The original figure does not show any fine lines, and the description says with four approximate equal impressed lines. I therefore figured this form as new; but on examining the type at Philadelphia Academy, it proved to be like the species figured. There is some confusion here which needs further investigation.

CYPRÆA SMITHII, n. sp. Pl. 5, fig. 3.

Shell oblong-ovate, rather flat, surface smooth ; labrum crenulate within, smooth on the base and flattened, reflected somewhat and raised above base of shell ; aperture slightly crenulate within, expanded below.
Locality.—Gregg's Landing, Ala.

Named in honor of Dr. Eugene A. Smith, of Tuscaloosa, Ala.

CASSIS (SEMICASSIS) SHUBUTENSIS, Aldr. Pl. 2, figs. 5a, b.

Cassis (*Semicassis*) *shubutensis*, Aldr. J. C. S. N. H., July, 1885.

CASSIDARIA BREVIDENTATA, Aldr. Pl. 1, fig. 20.

Cassidaria brevidentata, Aldr. J. C. S. N. H., July, 1885.
Cassidaria carinata, Lam. (Aldr.) J. C. S. N. H., July, 1885.

In the article published in 1885, the first-mentioned form was given a new name on account of a strong varix, and the second form given Lamarck's name. Upon comparison with the French shell, I have found differences enough to place our shell in another species, and unite it to *C. brevidentata*, *Nobis*, although it has no varix and is much more ponderous.

CASSIDARIA DUBIA, Aldr. Pl. 1, fig. 21.

Cassidaria dubia, Aldr. J. C. S. N. H., July, 1885.

NATICA RECURVA, n. sp. Pl. 5, fig. 10.

Shell large, globose, smooth, whorls six, spire low ; suture channeled, that part of the whorls within this groove concave, rising to a shoulder. Body whorl very large, flattened on upper part, abruptly rounded below the umbilicus ; aperture semilunar, rounded anteriorly and narrowed at the posterior part ; callus thick, spreading over the body whorl and partially covering the umbilicus. Umbilicus large, deep, striated within, a thickened callus or rib proceeding from the lower edge of the outer lip, and rounding into the umbilicus.
Locality.—Lisbon, Ala.

The type shows on the body whorl traces of numerous revolving color lines.

Capulus complectus, n. sp. Pl. 6, figs. 1, 1 a.

Shell flattened, irregular in form; whorls three, the first two forming a spiral on the body whorl; surface finely striated with concentric lines. Interior edged; a large horseshoe muscular impression, very slightly impressed, shows the generic position.

Localities.—Wood's Bluff Group, Hatchitigbee, and Lisbon, Ala.

Found occupying the cavities of other shells. Young specimens might readily be mistaken for *Velutina;* older forms resemble an operculum. In young shells the nucleus is about central; in older forms on the right side; looks like *Pileopsis squamæformis,* Lam., from the Paris basin.

No. 1 is from Wood's Bluff; 1 a. from Hatchetigbee.

Scalaria Whitfieldi, Aldr. Pl. 1, fig. 18.

Scalaria Whitfieldi, Aldr. J. C. S. N. H., July, 1885.

Scalaria octolineata, Con. Pl. 1, fig. 22.

See the *Jour. Cin. Soc. Nat. Hist.* for notes upon this species.

Turritella bellifera, Aldr. Pl. 1, fig. 13.

Prof. Heilprin considers this form as a variety of *T. humerosa,* Con., but I prefer to let it remain pending a careful review of these difficult forms.

Cerithium Langdoni, Aldr. Pl. 1, fig. 14.

Cerithium Langdoni, Aldr. J. C. S. N. H., July, 1885.

Cerithium Tombigbeense, n. sp. Pl. 3, fig. 7.

Shell elongated, whorls probably twelve; suture distinct, situated in a depressed space; surface of the uppermost whorls smooth, those following transversely striated—the lower ones, with numerous oblique longitudinal ribs, rising into tubercles upon the center of the body whorl and the two next above; a wavy line just below the suture, making a slight shoulder to the whorls. Lines of growth sigmoid, fine and numerous upon the body whorl, obsolete above. Aperture ovate, outer lip reflected below, making a short, open canal.

Locality.—Wood's Bluff, Ala.

Only one specimen found; the mouth is broken away, rendering it impossible to determine its generic position absolutely. The apex is also missing, but is probably sharp. Suggests the genus *Melania.*

MELANOPSIS CHOCTAVENSIS, n. sp. Pl 3, fig. 8.

Shell oblong-ovate; whorls six, shouldered; spire obtuse, the upper part generally plicate; suture impressed distinct. Body whorl constricted below the shoulder, smooth on the main part; fine revolving lines below and often a few on the shoulder, sometimes continuing to the apex just below the suture. Aperture oblong-ovate, canaliculate at base; outer lip smooth, slightly thickened within; columella with a thickened and reflected callus.

Localities.—Hatchetigbee, Butler, Choctaw County, Ala.

Resembles closely the figure of *Melanopsis quadrata*, Con., from the Miocene. It is rather variable in form, very common at the typical locality (Hatchetigbee).

MELANOPSIS ANITA, n. sp. Pl. 5, fig. 12.

Shell ovate, spire short, surface smooth, body whorl large; aperture large, angular posteriorly, caused by a thick deposit of callus; outer lip sharp, thin; callus reflected below, terminating in a small excision.

Locality.—Gregg's Landing, Ala.

This species differs from *Melanopsis Choctawensis*, above described, by its not having a caniculate aperture below the lower spire, and having a larger aperture.

TROCHUS ALABAMENSIS, n. sp. Pl. 5, fig. 16.

Shell trochiform, whorls seven, suture deeply impressed; surface marked with four to six strong, revolving lines, with finer ones between, crossed by numerous fine longitudinal striations, which are strongest at the intersecting points; base of the body whorl with finer lines. Umbilicus deep, defined by a sharp carina; aperture rounded; outer lip crenate on its edge, the crenulations running some distance within; inner lip smooth.

Locality.—Matthews' Landing, Ala.

Generally is smaller than the type; not rare.

SCAPHANDER PRIMUS, Aldr. Pl. 2, fig. 7 a, b.

Scaphander primus, Aldr. J. C. S. N. H., July, 1885.

HAMINEA GRANDIS, n. sp. Pl. 3, fig. 1.

Shell large, very thin, broadly ovate, summit rounded, with a deep pit marking the position of the spire. Surface covered with narrow, transverse striæ, with rounded spaces between; spaces below the center again subdivided by more shallow lines, closer set as the base is approached, but nearly obsolete at apex; lower extremity obliquely but broadly rounded; aperture rather large, nearly equal in width as far as shown. Inner lip represented by an exceedingly thin lamina, reflected, showing in the type a narrow, oblique umbilicus.

Locality.—Bunker Hill, La.; Jackson Group.

This species is the largest yet described from the Southern Tertiary. The specimen is partly a cast; substance of shell is thinner than ordinary writing-paper. The lines of growth and transverse striæ are well shown on cast.

HAMINEA ALDRICHI, Langdon.

Bulla (Haminea) Aldrichi, Langdon. *Am. Jour. Sci.*, March, 1886.
Bulla biumbilicata, Mr. P. A. N. S., Philadelphia, 1884, fig. p. 110.

Dr. Meyer's name is preoccupied by Deshayes' in *Des Animaux sans vertebres dans Le Bassin de Paris*, Atlas, vol. 2, pl. 39, figs. 33, 34 and 35. It is quite likely, however, that this shell may prove to be the true *biumbilicata* of Deshayes.

PELECYPODA.

TEREDO CIRCULA, n. sp.

Consisting of a long, circular, shelly sheath, terminating at the smaller end in two siphons, which are also nearly circular in section. These siphons are partially separated in one specimen, and one is larger than the other; substance of the sheath rather thick; shell smooth at the outer end and annulated and enlarged at the further end. Generally straight or only slightly contorted.

Localities.—Choctaw Bluff, Ala., and Wayne County, Miss., in White Limestone; Vicksburg Group.

Found boring in the limestone in great numbers, standing vertically; the valves not found. Mentioned in previous article as *Aspergillum* tubes, but having since visited Choctaw Bluff and found the terminal tubes, I have ventured to give it a name. No imbricated ledges found in any of the specimens.

PHOLAS ALATOIDEA, n. sp. Pl 4, figs. 9, 9 b, 9 c.

Shell elongate, cylindrical, posterior end concentrically striated, anterior half of the shell crossed with raised radial lines forming imbrications, which grow stronger as we approach this end. Anterior dorsal margin winged, this part showing only the continued concentric lines; umbonial processes large, reflected; anterior ventral margin strongly notched. Internal process broad, spatulate.

Localities.—Gregg's Landing and Bell's Landing, Ala.

This shell was no doubt the one found by Prof. Tuomey and given in his list of species at Bell's Landing under the name of *Pholas Roperiana.* He never described it; the figure (9) nine is erroneously numbered 4′ by the lithographer.

MARTESIA ELONGATA, n. sp. Pl. 4, fig. 10.

Shell gaping above, elongated, sub-cylindrical; the anterior and central part of surface marked with concentric ribs, balance of posterior smooth. A strongly impressed groove running from the beaks to the ventral margin, the concentric ribs being more prominent on the sides of this groove.

Beaks strongly recurved toward the anterior, situated close to this end, which is truncate.

Locality.—Yellow Bluff, Ala., Bell's Landing Group.

This species was taken from a piece of lignite by D. W. Langdon, Jr. The shell has the markings of the dorsal accessory plate.

SOLEN LISBONENSIS, n. sp. Pl. 4, fig. 4.

Shell linear, nearly straight; posterior sub-truncate; anterior obliquely rounded with a depressed space behind running to the beaks; lines of growth prominent, bending at right angles along a line running obliquely from the beaks to the junction of the posterior and ventral margins. Anterior widely gaping.

Locality.—Lisbon, Ala., just above the Buhrstone.

MACHA VICKSBURGENSIS, Aldr. Pl. 2, fig. 1.

Solecurtus Vicksburgensis, Aldr. J. C. S. N. H., July, 1885.

PANOPÆA PORRECTOIDES, n. sp. Pl. 4, fig. 3.

Shell thin, oblong, ventricose; surface marked by lines of growth; anterior side expanded, posterior produced. Ventral margin nearly straight. Beaks incurved, pointed, wrinkled by lines of growth. The posterior end widely gaping, and has a wedge-shaped appearance. Tooth strong, blunt below, sharp above; hinge line short.

Locality.—Baker's Bluff, Ala., Ferr. Sand Bed.

The differences between this form and the Miocene *P. porrecta*, Con., are very slight. Left valve figured.

NEÆRA PRIMA, n. sp. Pl. 6, fig. 14.

Shell rotund, covered with rounded, close-set concentric striæ; posterior with four radiating ribs; anterior part smooth. Rostrum moderate, narrow, rounded, with a concave, almost triangular space between it and the body of the shell, the end curving upward; ventral margin hollowed out; dorsal margin rising slightly above the hinge line. Cartilage pit, minute, bent inward in left valve, which also has the posterior muscular impression strongly defined by a rib on the inner side running to the dorsal margin; hinge line nearly straight.

Locality.—Wood's Bluff, Ala. (lower bed).

NEÆRA ALTERNATA, n. sp. Pl. 6, fig. 15.

Shell small, moderately rotund, covered with very fine concentric lines; rostrum short, obtuse, rounded on top and angulated on dorsal margin; lines of growth becoming lamellar on its surface. Hinge line and dorsal line of rostrum straight. Cartilage pit minute, narrow, oblique and close under the beaks.

Locality.—Lisbon, Ala.

Distinguished from the preceding species by its lack of radiating ribs, smoother surface, and is much less rotund. Has a strong resemblance to the recent *Neæra lamellosa*, Sars.

PHOLADOMYA CLAIBORNENSIS, n. sp. Pl. 4, fig. 5.

Shell exceedingly thin, pearly, concentrically ribbed, crossed by radial lines, which are strong on the umbones; beak high, very prominent close to the anterior end of shell, anterior truncated abruptly; posterior produced, flattened on the upper part; lunule long and narrow, smooth; hinge raised, prominent.

Locality.—Lisbon, and beds at base of Claiborne Bluff, Ala.

This species is close to *P. Marylandica*, Con., but appears to differ from that species in height of beaks and their more anterior position, besides being abruptly truncated and posterior flattened.

ASTARTE CONRADI, Dana, sp. Pl. 4, fig. 7.

Shell thin, oblong-ovate, concentrically wrinkled with broad, rounded plaits, concavities between nearly smooth. Covering the whole surface are fine, concentric lines, stronger on top of the plications; beaks flattened, blunt, and turned toward the anterior; lunule heart-shaped, separated by an indistinct ridge; hinge line nearly straight.

Localities.—Lisbon, Coffeeville, and beds at base of Claiborne Bluff, Ala.

The dentition removes this species to *Lutraria*. Prof. Marsh, at the request of Prof. J. D. Dana, has kindly allowed me to examine the type specimens. The one figured by Prof. Dana has been considerably distorted by pressure, and therefore misled Prof. Heilprin, who considered it a young *Crassatella alta*, Con. I figure the normal form. Ranges from the calcareous sand-bed down to the Buhrstone. The largest specimen found measures nearly two inches in length. Very close to *L. lapidosa*, Con.

CYTHEREA HATCHETIGBEENSIS, n. sp. Pl. 4, fig. 1.

Shell rather thick, inflated, subrotund, transversely striate—the different periods of growth marked by a dropping down of the concentric lamina, giving a ridge-like appearance; umbones swollen; beaks elevated; lateral tooth in left valve transverse, conical and strong; ligament short-curved; excavation of the pallial impression angular; margin of the shell entire, thickened in some specimens.

Locality.—Hatchetigbee Bluff, Ala., beneath the Buhrstone.

Prof. A. Heilprin considers this shell as *C. discoidalis*, Con., but that is described as having the inner margin crenulate, while this is smooth. Conrad's species has never been figured.

CARDIUM HATCHETIGBEENSE, n. sp. Pl. 4, figs. 12, 12a, 12b.

Shell large, subquadrate, ventricose with about thirty-two ribs; ribs flattened oval, with the scars of spines visible along their center, a few coarse, flattened, triangular spines remaining on the posterior and anterior; largest on the posterior, which is subtruncate, the largest rib forming the angle; marginal serrature largest at the angle. The flattened spaces between the ribs are equal in width to the ribs and nearly smooth, showing faintly the lines of growth. Cardinal teeth in left valve double—the lower one the largest, very strong and erect.

Locality.—Hatchetigbee Bluff, Ala.

CARDIUM TUOMEYI, n. sp. Pl. 4, figs. 13, 13a.

Shell ovate, thick through the umbones; ribs numerous, about forty-four in number, flattened above and indented with scars of spines; spaces between the ribs much smaller than the ribs themselves; a few small, scattered spines near the beaks, which are central and raised; muscular scars strongly marked.

Locality.—Nanafalia, Ala.

Differs from the previous species described by its more numerous ribs, more rounded form, smaller spines and thicker shell. The figure 13a shows the teeth of the left valve.

CARDIUM EUFAULENSE, Con. Pl. 6, fig. 5.

A cretaceous fossil (or described as such) received from Dr. William Spillman, of Mississippi. Probably an error in locality.

VERTICORDIA EOCENSIS, Langdon. Pl. 6, fig. 13.
V. eocensis, Langdon. *Am. Jour. Sci.*, March, 1886.

Figured at the request of Mr. Langdon.

NUCULA MONROENSIS, n. sp. Pl. 4, fig. 2.

Shell ovate-elliptical, subangular behind; surface covered with raised concentric ribs, sharp on their upper edge and slope downward toward the ventral margin; beaks recurved; lunule faintly marked, but large; cavity of the shell rather deep; margin crenulated.

Locality.—Calcareous sand-bed lower part of Claiborne Section, Monroe County, Ala.

CUCULLÆA TRANSVERSA, Rogers. Pl. 4, fig. 11, 11a.

The figure is from a specimen found at Gregg's Landing, Ala. Very large individuals two and one-half inches in length occur. Prof. Heilprin has placed the genus *Cucullæa* in *Arca* as a subgenus, and changes the name of this species to *C. Rogersi*, because the name *transversa* is preoccupied in *Arca;* but as both Tryon and Zittel consider the genus a good one, the old name ought to stand.

PECTEN (PLEURONECTIA) ALABAMENSIS, n. sp. Pl. 4, fig. 8.

Shell small, suborbicular; upper valve covered with equidistant concentric lines which run over upon the anterior ear; a few raised radial lines upon the center and anterior side; ears small; right valve nearly smooth ; within both valves eight raised prominent rounded ribs, becoming obsolete as they approach the beak.

Locality.—Matthews' Landing, Ala.

Seems to unite *Pleuronectia* and *Pecten*. One specimen shows concentric striæ and ribs in the younger part of the shell, these becoming obsolete toward the ventral margin. The enlarged figure gives a view of the interior.

ANOMIA EPHIPPIOIDES, GABB., VAR., LISBONENSIS, new var. Pl. 4, fig. 6.

Shell thin, pearly, suborbicular; upper valve smooth, slightly wrinkled on the umbo; lines of growth distant, hinge line doubly sigmoid, the extremities winged. Muscular scars indistinct.

Locality.—Lisbon and beds at base of Claiborne Bluff.

The type is externally marked with broad radiating bands of color. On comparison with A. ephippioides, Gabb., it appears much larger and more transverse; that species is not smooth externally, and is often plicate. It occupies the same horizon however.

OSTREA JOHNSONI, n. sp. Pl. 6, fig. 6.

Shell large, thick; both valves convex; beaks pointed in lower valve; breadth of shell greater than length; both valves strongly plicate, generally with six folds, the plications becoming very deep with age, the concave part between the two basal folds, running out into a long curved tongue; surfaces strongly laminated, laminæ terminating at edge of shell; attachment scar not visible; ligamental area with a rather deep transversely striated furrow in the lower valve, shallower and broad in the upper; muscular scar, large nearest the base and posterior margin; curved, spatulate, nearly straight on upper side.

Locality.—Monroe County Calc. Sand-bed, Claiborne and Lisbon, Ala., also Newton, Miss.

Named in honor of Lawrence C. Johnson, of the U. S. Geological Survey. This form seems to be confined to the Lower Claibornian above the Buhrstone.

PART II.

Geological Distribution and Localities of Species.

When the species mentioned are in my cabinet, or that of the State University or quoted from some previous author, appropriate signs are used as follows:

My cabinet,	*
State collection,	‡
Prof. A. Heilprin,	†
T. A. Conrad,	‖
S. G. Morton,	§
Dr. O. Meyer,	¶

Nearly all the species, however, are either in the State University cabinet or my own. For the stratigraphical succession of the different groups, the reader is referred to Dr. E. A. Smith's explanatory article accompanying this report.

TABLE I.

White Limestone Group.

This formation needs more careful examination, especially in its upper beds. The western part of Alabama shows the beginning of the change that takes place in Mississippi. The most peculiar "find" in connection with this group is the presence of *Ven. planicosta*, Lam. One large valve was found on the top of a high Limestone hill, five miles north of Claiborne, by the writer.

Many of the shells exist only as casts, rendering the absolute determination almost impossible.

Following the names, column one shows those found in the vicinity of Claiborne.

2. those found at a locality in Clark County, Ala., S. 35, T. 9, R. 6, called "The Rocks."

3. Choctaw Bluff, Clarke County, Ala., the most southerly extension of the Tertiary on the Alabama River.

4. St. Stephens' Bluff, on Tombigbee River. The column on the left shows whether the species is in my cabinet or not.

My Cabinet.	Name.	Vicinity of Claiborne.	"The Rocks," Clark Cr., Ala.	Choctaw Bluff, Ala.	St. Stephen's.	Remarks.
*	Nautilus Alabamensis, Mor	*				
*	Cypræa fenestralis, Con		+			
*	Scalaria, sp		+			
	Conus sauridens? Con. (cast)		+			
*	Turritella, sp. (impression)	*				
*	Pecten perplanus, Mor	*	+		*	
*	" Poulsoni, Mor	*		*	*	
	" anatipes, Mor	*				
*	Ostrea Mortonii Gabb (= panda, Mor. pars.)	*				
*	" cretacea, Mor		+			
*	" Georgiana, Con			*		
*	" sp			*		
*	" Tuomeyi? Con				*	
*	Gryphæa vomer, Mor		+	*	*	
*	Spondylus dumosus, Mor		+		*	
*	Terebratulina lachryma, Mor		+			
	Modiola cretacea, Con		+			
*	Crassatella, sp. (cast)			*		
*	Cytherea, sp. (cast)	*		*		
*	Leda, sp			*		
*	Lithodomus, sp. (casts)	*				
*	Pectunculus, sp. (cast)	*				
*	Teredo circula, Aldr					Miss.
*	Venericardia planicosta, Lam	*				
*	Orbitoides Mantelli, Mor	*			*	
*	Scutella Rogersi, Mor	*				
*	" Lyelli, Con	*				
*	" crustoloides, Mor	*				
	Serpula, sp		+			
*	Coral, massive	*				
*	Echinus infulatus? Mor	*				
*	Cidaris, sp	*				
*	Sword of Cœlorhynchus					
*	Carcharodon augustidens, Ag					
	Zeuglodon cetoides					

The massive coral is also found at Central Salt Works, Ala., where it comprises the greater part of a hill over one hundred feet high.

TABLE II.

Fossils from the "Ferruginous Sand-bed" (Claiborne sand) at base of Baker's Bluff, one mile above St. Stephen's Bluff, on Tombigbee River. As the stratigraphical position of this locality has been disputed, this table is here given:

Pseudoliva vetusta, Con.
Ancillopsis subglobosa, Con.
Trochita trochiformis, Lam.
Melongena alveata, Con.
Rostellaria (Calyptrophorus) alveata, Con.
Oliva Alabamensis, Con.
Ancillaria staminea, Con.
Cylichna galba, Con.
Turbinella pyruloides, Con.
Voluta petrosa, Con.
Caricella doliata, Con.
Tornatella bella, Con.
Crepidula lirata, Con.
Hipponyx pygmæa, Lea.
Bulla biumbilicata, Mr.
Solarium elegans, Lea.
Dentalium thalloides, Con.
Mesalia obruta, Con.
" striata, Lea.
Cadulus, sp.
Pleurotoma Desnoyersi? Lea.
" elaborata? Lea.
Natica limula, Con.
" ætites, Con.
Cerithium, sp.?
Mitra fusoides, Lea.
Actæon pygmæus, Lea.

Pecten Deshayesii, Lea.

Venericardia alticosta, Con. (transversa,
" rotunda, Lea. Lea.)
" Sillimani, Lea.
Avicula limula, Con.
Cytherea Poulsoni, Con.
" perovata, Con.
" æquorea, Con.
Crassatella protexta, Con.
" alta, Con.
Astarte Nicklinsii, Lea.
" sulcata, Lea.
Leda protexta, Con.
" plicata, Lea.
Corbula oniscus, Con. var. carinata,
" nasuta, Con. [Con.
Arca rhomboidella, Lea.
Pectunculus stamineus, Con.
Nucula magnifica, Con.
Egeria rotunda, Lea.
Lucina papyracea, Lea.
" subvexa, Con.
Panopæa porrectoides, Aldr.

Endopachys maclurii, Lea.
Flabellum, sp.
Discoflustrellaria Bouei, Lea.
Capularia discoidea, Lea.
Heteractis Duclosii, Lea.
Lunulites interstitia, Lea.

The Claiborne Sand-bed also occurs bearing the identical species found at the typical locality at

Stave Creek, Ala., S. 18, T. 7, R. 2, E.
Satilpa Creek, Clark County.
Allen's Creek, Clark County.
At Mr. White's in Monroe County.

These localities will be reviewed in a final report.

TABLE III.

MIDDLE AND LOWER CLAIBORNIAN.

This list includes all the strata between the Calcareous Sand-bed and the next group beneath (Hatchetigbee). There are three horizons in the Claibornian, which are rich in fossils and present features peculiar to each.

1st. The famous Claiborne "Furruginous Sand."

2d. The bed near the base of the Claiborne Bluff called the "Calcareous Sand-bed."

3d. The Lisbon strata down to the Buhrstone.

Excepting the Buhrstone, all the localities given below belong to the second and third horizons—as follows:

Horizon of the Calcareous Sand-bed.

1. Calc. sand-bed proper at Claiborne.
2. T. A. Rumbley's, Monroe County, Ala.
3. Coffeeville Landing, Ala.
4. Near Barrytown, Ala.

Lisbon Horizon.

5. No. 9, Claiborne section (*Am. Jour. Sci.*, October, 1885, and above in Dr. Smith's Summary).
6. No. 10, Claiborne section.
7. Lisbon, in general.
8. Lowest beds at Lisbon.
9. Buhrstone.

(*All the species are in my cabinet.*)

Name.	1 Calc. Sand.	2 Monroe Co.	3 Coffeeville.	4 Near Barrytown.	5 No. 9, Claiborne.	6 No. 10, Claiborne.	7 Lisbon.	8 Lowest Lisbon.	9 Buhrstone.
Ancillaria altile, Con							*		
" subglobosa, Con					*		*		
" staminea, Con		*					*		
" expansa, Aldr							*		
Agaronia punctulifera, Gabb							*		
Rostellaria Whitfieldi, Heilpr.							*		
" velata, Con							*		
Siliquaria vitis, Con						*	*		
Monoptygma Leai, Whitf.							*		
Mitra fusoides, Lea.							*	*	
" dumosa, Con., var							*		

Name.	1 Calc. Sand.	2 Monroe Co.	3 Coffeeville.	4 Near Barrytown.	5 No. 9, Claiborne.	6 No. 10, Claiborne.	7 Lisbon.	8 Lowest Lisbon.	9 Buhrstone.
Mitra Haleanus, Whitf							*		
" bolaris, Con		*					*		*
" biconica, Whitf							*		
Murex engonatus, Con							*		
Terebra gracilis, Con							*		
" multiplicata, H. C. Lea							*		
" divisura, Con., var							*		
" plicifera? Heilpr							*		
Marginella incurva, Lea							*	*	
Dentalium arciformis? Con		*					*	*	*
" thalloides, Con							*		
" multistriatum, Heilpr		*					*		
Hipponyx prgmæus, Lea								*	
Tuba antiquata, Con								*	*
Odontopolys compsorhytis, Gabb					*	*	*		
Trochita trochiformis, Lam		*			*		*		
Natica limula, Con							*		
" gibbosa, Lea					*	*	*		
" minor, Lea							*		
" mamma, Lea							*		
" Newtonensis, M. & A							*		
" sp.						*		*	*
" Lisbonensis, Aldr		*				*	*		
Sigaretus bilix, Con							*		*
" declivis, Con						*			
" (Sigaticus) Bœttgeri, M. & A							*	*	
Crepidula lirata, Con		*	*				*		
Pseudoliva vetusta, Con		*			*	*	*		
Turbinella pyruloides, Con							*		
Conus sauridens, Con							*		
Voluta petrosa, Con						*	*		
" Sayana, Con., var					*		*		
Turritella Mortoni, Con		*				*	*		
" humerosa? Con							*		
" n. sp						*	*		
" eurynome? Whitf						*	*		
" nasuta, Gabb							*		
" carinata, Lea		*			*	*	*		*
Mesalia obruta, Con		*			*	*	*		
" vetusta, Con							*		
Fusus raphanoides, Con							*		
" crebissimus? Lea							*		
" sp							*		
" limulus, Con							*		
" pagodiformis, Heilpr							*		
" Mortoniopsis, Gabb									
" irrasus, Con							*	*	
" trabeatus, Con., var					*				
" sp									
Cornulina armigera, Con							*		

Name.	1 Calc. Sand.	2 Monroe Co.	3 Coffeeville.	4 Near Barrytown.	5 No. 9, Claiborne.	6 No. 10, Claiborne.	7 Lisbon.	8 Lowest Lisbon.	9 Buhrstone.
Mazzalina pyrula, Con							*		
Cadulus abruptus, M. & A.		*					*		
Buccinum Mohri, Aldr							*		
Neptunaea enterogramma, Gabb						*	*		
Capulus complectus, Aldr							*		
" n. sp?							*		
Cylichna galba, Con							*		*
" subradius, Mr									*
" Dekayi, Lea							*		
Bulla Aldrichi, Langdon	*								
Nassa Calli, Aldr							*		
" cancellata, Lea		*	*						*
Phos Texana, Gabb							*		
Cerithioderma, n. sp							*		
Cerithium vinctum, Whitf							*		
Pleurotoma terebralis, Lam							*		
" sp							*		
" sp		*				*	*		
" sp							*		
" sp							*		
" sp							*		
" sp							*		
" sp							*		
" sp							*		
" sp							*		
" sp									*
Cassis Taitii ? Con							*		
Fasciolaria polita, Gabb							*		
Ringicula biplicata ? Lea		*					*		*
Oliva bombylis, Con							*		
" Alabamensis, Con		*							
Pyrula cancellata, Lea							*		*
Actæon elevatus, Lea							*		
" lineatus, Lea							*		
" melanellus, Lea		*					*		
" pygmæus, Lea							*		
Turbo naticoides, Lea		*							
Solarium cancellatum, Lea		*							
" **scrobiculatum, Con**							*		
" **ornatum, Lea**							*		
" **sp**							*		
" **elegans, Lea., var**							*		
Teinostoma subrotunda, Mr							*		
Delphinula plana, Lea							*		
" **dipressa, Lea**							*		
Planaria nitens, Lea							*		
Cancellaria alveata, Con							*		
Busycon, n. sp							*		
Scalaria, sp							*		
Odostomia, 2 sp									*

Name.	1 Calc. Sand.	2 Monroe Co.	3 Coffeeville.	4 Near Barrytown.	5 No. 9, Claiborne.	6 No. 10, Claiborne.	7 Lisbon.	8 Lowest Lisbon.	9 Buhrstone.
Nautilus, sp.									*
Belosepia ungula, Gabb.		*					*		
Lucina compressa, Lea		*					*		
" Claibornensis, Con		*			*		*		
" impressa, Lea							*	*	
" subvexa, Con		*					*		*
" papyracea, Lea		*					*		*
" lunata, Lea		*							
" carinifera, Con		*							
Amphidesma linosa, Con					*	*	*		
" tellinula, Con								*	
Crassatella alta, Con							*		
" protexta, Con		*			*		*		
" palmula? Con						*			
Alveinus minutus, Con						*			
Venericardia, densata, Con					*	*	*		
" rotunda, Lea		*					*	*	*
" Sillimani, Lea		*					*		
" parva, Lea	¶								*
Avicula limula, Con	*	*			*		*		
Solen Lisbonensis, Aldr								*	
Cardium Nicolleti, Con., var							*		
Petunculus staminens, Con		*					*	*	
Limopsis declivis, Con					*	*	*		
" decisus, Con					*	*	*		
" ellipsis, Lea		*					*	*	*
" cuneus, Con							*		
Trigonocælia ledoides, Mr.							*		
Astarte parva, Lea							*		
" minor, Lea							*		
" sp							*		
" Conradi, Dana	*		*		*	*	*		
Mactra prætenuis, Con							*		
" parilis, Con							*		
" Grayi, Lea							*		
Corbula oniscus, Con							*	*	
" nasuta, Con		*			*	*	*		
" gibbosa, Lea			*				*		*
" Murchisonii, Lea (var. fossata, M. & A.)		*							
Pecten Dehayesii, Lea	*	*	*			*	*		*
" scintillatus, Con	*				*		*		
" calvatus? Mor							*		
Arca rhomboidella, Lea			*		*	*	*		
Bysoarca Mississippiensis, Con		*							
Leda media, Lea							*		
" multilineata, Lea							*		
" n. sp								*	
Neæra alternata, Aldr							*		
Nucula magnifica, Con		*	*		*	*	*		

Name.	1 Calc. Sand.	2 Monroe Co.	3 Coffeeville.	4 Near Barrytown.	5 No. 9, Claiborne.	6 No. 10, Claiborne.	7 Lisbon.	8 Lowest Lisbon.	9 Buhrstone.
Nucula ovula, Lea							*		
" cœlata, Con							*		
" pulcherrima, Lea							*		
" media, Lea							*		*
" semen, Lea		*					*		
" Clairbornensis, Con					*	*	*		
" Monroensis, Aldr		*							
Cytherea Poulsoni, Con		*			*		*		
" perovata, Con		*			*		*		
" æquorea, Con	*						*		
" minima, Lea							*		
" trigoniata, Lea					*				*
Plicatula filamentosa, Con									*
Kelliella Bœttgeri? Mr							*		
Teredo, sp.?									*
Tellina nitens, Lea							*		
" ovalis, Lea					*	*	*		
" scandula, Con							*		
Ostrea Johnsoni, Aldr		*					*		
" sp							*		
" sellæformis, Con	*	*	*		*	*	*		
" divaricata, Lea	*	*	*			*	*		
Anomia ephippioides var. Lisbonensis, Aldr	*				*		*		
Egeria rotunda, Lea		*			*		*		
" plana, Lea							*		
" sp.?		*							
Dosinia, n. sp					*	*			
Hindsiella, n. sp. (not faba, Mr.)							*		
Grateloupia Moulinsii, Lea							*		
Pholadomya Claibornensis, Aldr					*	*			
Pinna, sp. (very large)		*	*						
Lunulites Duclosii, Lea		*					*		
Flabellum Wailesii? Con			*				*		
Turbinolia Maclurii, Lea	*	*					*		
" pharetra, Lea							*		
Lunulites Bouei, Lea							*		
Platytrochus Stokesii, Lea							*		
Madrepora, 2 sp		*					*		
Cyclosmilia?			*				*		
Serpulorbis, sp.?							*		
Serpula ornata, Lea		*							
Scutella Lyelli, Con	*			*					
Echinus ——, sp							*		
Scalpellum eocense, Mr	*	*							
Mylobates ——		*					*		
Otolithus		*					*	*	
Foraminifera (1 sp.)							*		

TABLE IV.

HATCHETIGBEE GROUP.

Found at Hatchetigbee Bluff on the Tombigbee River beneath the Buhrstone. A large bed of *Ven.* planicosta, Lam., about two feet thick is seen here at low water, and millions of this species could be obtained. The shore line of the river looks like an ocean beach from the abundance of this form.

Especial attention is called to the very remarkable fauna found here.

Natica limula? Con.
" Mississippiensis? Con. (*umbilicated var.*).
" parva, Lea.
Sigaretus (Sigaticus) Clarkeanus, Aldr., mss.
Nassa cancellata, Lea.
Cerithium, n. sp.
Melanopsis Choctawensis, Aldr.
Voluta petrosa? Con.
V. (Athleta) Tuomeyi, Con.
Pseudoliva vetusta, Con.
Ancillaria subglobosa, Con.
Oliva bombylis, Con.
Cominella Hatchetigbeensis, Aldr.
" striata, Aldr.
Cornulina armigera, Con.
Fusus trabeatus, Con.
" pagodiformis, Heilpr.
" subscalarinus, Heilpr.
" subtenuis, Heilpr.
" sp.?
" 2 sp.
Turritella, sp.
" carinata, Lea.
Rostellaria trinodifera, Con.
Pyrula juvenis, Whitf., (multangulata, Heilpr.).
Dentalium, sp.
Capulus complectus, Aldr.
Trochita trochiformis, Lam.
Tornatella bella, Con.
Cadulus, sp.
Mitra dumosa, Con., var.
" Hatchetigbeensis, Aldr.
Pleurotoma, 4 sp.
Trophon caudatoides, Aldr.
Triton, n. sp.
Columbella, sp.
Cancellaria alveata, Con.
Solarium elegans, Lea., var.
Solarium granulatum, Lea.
Tuba antiquata, Con.
Scalaria sessilis? Con.

Cytherea Hatchetigbeensis, Aldr.
" Poulsoni? Con.
" sp.
" Nuttalliopsis, Heilpr.
Cardium Nicolleti, Con., var.
" Hatchetigbeensis, Aldr.
Venericardia planicosta, Lam.
" Sillimani, Lea.
" alticosta, Con.
Spondylus dumosus, Mor., var.
Corbula nasuta, Con.
Pectunculus stamineus, Con.
Ostrea Vicksburgensis? Con.
" cretacea, Mor.
" sellæformis, Con.
Gryphæa vomer, Mor.
Pecten, n. sp.
Leda protexta, Con.
" sp.
Astarte Nicklinsii, Lea.
Arca subprotracta, Heilpr. (protracta, Con.)
Crassatella producta, Con.
Plicatula filamentosa, Con.
Lucina rotunda, Lea.
" subvexa, Con.
" sp.
Mactra prætenuis, Con.
" n. sp.
Tellina papyria, Con.
Nucula plicata, Lea.
Mysia, sp.

Madrepora, sp.
Cyclosmilia, sp.

Otolithus.

TABLE V.

WOOD'S BLUFF GROUP.

This group has even a greater thickness than the Claiborne Sand, and is fully as crowded with fossils, though there is not so great an assemblage of species. The lower part (twelve to fifteen feet thick) is a mass of *Turritellas* (Turritella carinata? Lea, Heilpr.), the other species found in it being comparatively few in number.

The bed has been traced by Dr. E. A. Smith from near Turnbull, in Monroe County, westward almost to the Mississippi line. Numerous localities have been examined, the list below gives the species from each. In some cases, the exact bed is not designated in the collections from Wood's Bluff; these are given in a separate column. "Wood's Bluff upper" is the green sand-bed, two to four feet thick; "Wood's Bluff lower" that part below the five to eight feet of barren clays shown in section.

	Knight's Branch.	Cave Branch.	Wood's Bluff.	Wood's Bluff (upper).	Wood's Bluff (lower).	Choctaw Corner.	Bethel, Ala.	4 miles south Mt. Sterling.	Hendrick's Marl Bed.	Butler, Choctaw Co., Ala.	½ M. S. of Butler.
Ancillaria subglobosa, Con	†		†	*	*	*	*			*	*
" staminea, Con				*	*	*				*	
Natica ætites, Con	†	†		*	*	*	*	*		*	*
" Mississippiensis, Con			†								
" limula? Con.			†	*	*	*	*	*	*	*	*
" sp					*	*				*	
" magno-umbilicata, Lea					*	*				*	
" sp					*	*					
" gibbosa, Lea										*	
" sp										*	*
" n. sp.						*					*
Sigaretus (Sigaticus) Clarkeanus, Aldr						*		*			
" bilix, Con					*	*				*	
Turbinella (Caricella) Bandoni, Desh.	†				*			*			
Lævibuccinum lineatum, Heilpr	†			*		‡					
Rostellaria (Calyptrophorus) trinodifera, Con	†			*	*	—		*	*	*	*
Solarium cupola, Heilpr	†	†	†		*	*	*	*		*	
" delphinuloides, Heilpr			†		*	*					
" sp						*					
" elegans, Lea., var.											
Fusus interstriatus, Heilpr	†	†	†		*	*		*			

	Knight's Branch.	Cave Branch.	Wood's Bluff.	Wood's Bluff (upper).	Wood's Bluff (lower).	Choctaw Corner.	Bethel, Ala.	4 miles south Mt. Sterling.	Hendrick's Marl Bed.	Butler, Choctaw Co., Ala.	½ M. S. of Butler.
Fusus subtenuis, Heilpr	†	†		*	*	*				*	
" (Strepsidura) subscalarinus, **Heilpr.**	†	†		*	*	*		*	*	*	*
" pagodiformis, Heilpr		†	†	*		*					
" trabeatus, Con			†	*	*	*				*	*
" engonatus, Heilpr			†	*							
" Meyeri, Aldr			*		*						
" Tombigbeensis, Aldr					*						
" sp										*	
" (Strepsidura), **sp.?**					*						
" **n. sp**					*						
" **n. sp**					*						
" **n. sp**					*						
" **sp**					*						
Pyrula multangulata, Heilpr. (juvenis, Whitf.)		†	†		*	*				*	*
" **tricostata, Desh**		†			*						
Pyropsis perula, Aldr				*	*						
? Pleurotoma acuminata, Sowb		†		*	*	*					*
Pleurotoma moniliata, Heilpr		†	*	*	*						
" (Cochlispira) cristata, **Con**			†		*			*		*	
" n. sp			†								
" exilloides, Aldr					*						
" Tombigbeensis, **Aldr**					*						
" **Tuomeyi, Aldr**				*	*						
" **6 species**				*	*						
" sp				*							
" 2 **species**					*						
" **n. sp**					*						
Dentalium microstria, Heilpr		†	†		*	*	*	*	*	*	*
Cadulus, sp				*	*	*	*	*		*	
Turritella carinata? **Lea**		†	†	*	*	*	*	*	*	*	*
Cassidaria dubia, Aldr		†			*						
Voluta (Athleta) Tuomeyi, Con		†	†	*	*	*	*	*	*	*	
" petrosa? Con						*		*	*		*
Cancellaria evulsa, Brander (tortiplica? Con.)			†	*	*	*					
" **sp**					*	*				*	
Pseudoliva scalina, Heilpr.			†								
" vetusta, Con			†	*	*					*	
Ranella (Argobuccinum) Tuomeyi, **Aldr**					*						
Trochita trochiformis, Lam					*	*		*	*	*	
Phorus reclusus? Con					*	*					
Melanopsis Choctawensis, Aldr										*	*
Turbonilla (Chemnitzia) trigem**mata, Con**				*	*						
Trophon gracilis, Aldr					*						
Cerithium Tombigbeense, Aldr					*						
Bulla Aldrichi, Langdon					*	*					
" **n. sp**						*					

	Knight's Branch.	Cave Branch.	Wood's Bluff.	Wood's Bluff (upper).	Wood's Bluff (lower).	Choctaw Corner.	Bethel, Ala.	4 miles south Mt. Sterling.	Hendrick's Marl Bed.	Butler, Choctaw Co., Ala.	½ M. S. of Butler.
Cylichna galba, Con					*			*		*	
Actæon punctatus, Lea					*						
Tornatella (Tornatellæa) bella, Con.	†			*	*	*	*	*	*	*	*
Tuba antiquata, Con					*					*	
Delphinula, sp					*	*					
Fissurella Claibornensis? Lea			‡								
Capulus complectus, Aldr					*						
Pisania? dubia, Aldr			*								
Odostomia, sp					*	*					
Cornulina armigera, Con				*						*	
Oliva bombylis, Con., var.					*			*		*	
Nassa cancellata, Lea.				*	*					*	
Eulima, 2 sp.				*	*					*	
Orbis rotella, Lea						*					
Ringicula biplicata? Lea.										*	
Hipponyx, sp										*	
Clavella, sp					*						
Columbella, n. sp					*						
Scalaria carinata? Lea					*						
Crepidula lirata, Con					*						
Astarte tellinoides, Con	†				*	*			*		
" **Nicklinsii, Lea., var.**					*			*			
Cytherea perovata? Con.	†				*	*	*		*	*	*
" Nuttalliopsis, Heilpr.	†			*	*	*	*		*		
" minima, Lea					*						
? Cardita alticosta, Con.	†		*		*		*	*		*	*
Venericardia planicosta, Lam.			*	*	*	*				*	*
Hippagus isocardioides, Lea.					*						
Corbula Aldrichi, Mr.	†			*	*	*	*				*
" n. sp										*	
Ostrea (*probably O. Thirsæ Gabb.*)	†	†			*		*		*		
" **sp.**			†							*	
Neæra prima, Aldr.					*			*			
Leda protexta, Con.		†	†		*	*			*	*	
" **n. sp**				*	*			*		*	
" **n. sp**					*	*	*			*	
Pecten Poulsoni, Mor.			†					*			
" sp					*	*					
" (Pleuronectia) **n. sp.**					*						
Modiola, sp.						*					
Nucula ovula, Lea., var.				*	*	*					
Protocardia Nicolleti, Con., var.		†			*	*		*	*		
Lucina, sp.					*	*				*	
" **subvexa, Con.**						*		*		*	
" **sp.**					*						
Tellinia, sp					*	*					

	Knight's Branch.	Cave Branch.	Wood's Bluff.	Wood's Bluff (upper).	Wood's Bluff (lower).	Choctaw Corner.	Bethel, Ala.	4 miles south Mt. Sterling.	Hendrick's Marl Bed.	Butler, Choctaw Co., Ala.	½ M. S. of Butler.
Avicula limula, Con					*						
Pinna, sp					*						
Mactra, sp					*						
Diplodonta, sp					*						
Pteropods, 2 sp					*						
Cyclosmilia, sp	†				*	*	*	*		*	*
Madrepora, sp					*						
Otolithus, sp					*						
Nodosaria, sp					*						
Foraminifera, 2 sp					*						

A small layer twenty-five feet above the Wood's Bluff beds was found to contain the following species:

Cytherea perovata? Con.
Corbula Aldrichi, Mr.
Lævibuccinum lineatum, Heilpr.
Rostellaria trinodifera, Con.
Leda, n. sp. (same as W. B.).
Nassa cancellata, Lea.

TABLE VI.

BELL'S LANDING GROUP.

This group includes a large marl-bed at Bell's Landing, Ala., also a smaller bed called "Gregg's Landing Marl," which is found at the base of the bluff at Bell's Landing and in the Gregg's Landing localities. Several bluffs occur where both are exposed in one profile—on the Alabama River, notably "Lower Peach-Tree Landing;" the Bell's Landing bed occurs on the Tombigbee River, and at Tuscahoma Landing, Ala. The tables give the following localities: "Bell's Landing bed," or "Bell's Upper;" "Bell's Lower," equal to "Gregg's Landing Marl;" "Gregg's Landing Marl," equal to "Gregg's;" "Lower Peach-Tree," equal to "Bell's" and "Gregg's," together, and "Tuscahoma," equal to "Bell's Landing bed."

The locality at Bell's Landing seems to have been favorable to the growth of large specimens. To give an idea of this, the dimensions attained by the following species have been taken; measurements are given in inches and tenths:

NAME.	Length.	Breadth.
Venercardia planicosta, Lam.	5.0	4.7
Ostrea compressirostra, Say., upper valve	5.5	6.5
" " " lower valve	6.0	6.5
Turbinella pyruloides, Con.	3.9	2.5
Voluta Newcombiana, Whitf	4.7	2.0
Rostellaria trinodifera, Con.	2.8	1.3
Pseudoliva scalina, Heilpr	4.3	2.7
Athleta Tuomeyi, Con	2.4	1.4
Turritella præcincta, Con	3.3	1.1
" bellifera, Aldr	3.7	0.7
? Fusus trabeatus, Con	2.3	1.2
Pseudoliva vetusta, Con	2.1	1.6
Bulbifusus Tuomeyi, Aldr	2.8	1.9
Crassatella tumidula, Whitf.	2.5	2.2
Pectunculus stamineus, Con.	2.0	2.1

	Bell's Upper.	Bell's Lower.	Gregg's Landing, Marl.	Lower Peach Tree.	Tuscahoma Landing.
Voluta Newcombiana, Whitf	*				
" (Athleta) Tuomeyi, Con	*				
" Sayana, Con., var.	*	*	*	*	*
Fusus trabeatus, Con.	*				*
" pagodiformis, Heilpr.	*	*	*		*
" " var	*				
" subtenuis, Heilpr	*	*	*	*	
" subscalarinus, Heilpr	*		*	*	
" sp.	*		*		
" sp.	*				
" (Strepsidura), sp.	*	*			
" " "					*
" spiniger, Con					*
" Meyeri, Aldr				*	
" n. sp.			*		
" rugatus, Aldr			*		
Pleurotoma terebralis, Lam.	*	*	*	*	*
" sp.	*	*	*	*	*
" nasuta, Whitf.	*	*	*	*	*
" sp.	*		*		
" n. sp		*	*		*
" n. sp. (smooth)			*		*
" capax, Whitf.		*	*		*
" sp.			*		
Turritella Mortoni, Con.	*	*	*		*
" præcincta, Con.	*		*		

	Bell's Upper.	Bell's Lower.	Gregg's Landing, Marl.	Lower Peach Tree.	Tuscahoma Landing.
Turritella bellifera, Aldr.	*		*	*	*
" **multilira, Whitf**	*		*		
" eurynome, Whitf.	*				
Mesalia vetusta, Con., var.				*	
Potamides Alabamiensis, Whitf.	*	*	*	*	*
Pseudoliva scalina, Heilpr.	*				
" vetusta, Con.	*				*
" elliptica, Whitf.					
" tuberculifera, Con.	*				
Turbinella baculus, Aldr.	*				*
" pyruloides, Con.	*				
Bulbifusus plenus, Aldr.	*				
" Tuomeyi, Aldr.	*		*		*
Pyrula juvenis, Whitf.	*	*		*	*
" tricostata, Desh. (Heilprin).	*				
Fulgur triserialis, Whitf.	*		*		
Cassidaria dubia, Aldr.	*		*		
Fasciolaria pergracilis, Aldr.		*	*	*	*
Pyropsis perula, Aldr.			*		*
Melongena, n. sp	*				
Pisania, n. sp.	*				
" **sp**		*	*		
Cypræa Smithii, Aldr			*		
Rostellaria trinodifera, Con	*	*	*	*	*
Aphorais gracilis, Aldr	*		*	*	
Trophon, sp.	*				
Murex, 2 sp.	*		*		
" **engonatus? Con**			*		
Triton, n. sp			*		
" autopsis, Con			*		
" exilis, Con.			*		
" n. sp			*		
Trochita trochiformis, Lam.	*		*		*
Nassa cancellata, Lea.		*	*		*
Natica erecta, Whitf.	*				
" Alabamensis, Whitf.	*	*	*	*	*
" aperta, Whitf.	*	*	*	*	*
" **onusta,** Whitf	*	*	*		*
" perspecta, Whitf.	*		*		
" parva, Lea., var	*				
" decipiens, Mr.	*		*		
" Mississippiensis, Con., **umbilicated var.**	*		*		
" **sp**	*	*	*		*
Sigaretus bilix, Con	*				
" **declivis, Con.**	*				
Cancellaria, sp.	*		*		
Oliva gracilis, Lea.	*		*		
Cadulus, sp.	*				*
" **3 sp.**			*		*
Dentalium microstria, Heilpr.	*				
Scalaria, n. sp			*		

	Bell's Upper.	Bell's Lower.	Gregg's Landing, Marl.	Lower Peach Tree.	Tuscahoma Landing.
Adeorbis depressus, Lea	*				
Teinostoma subrotunda, Mr	*				
Solarium elegans, Lea, var				*	
" delphinuloides, Heilpr			*		
" scrobiculatum, Con			*		
Velutina expansa, Whitf	*		*		
Cylichna galba, Con	*		*		
Bulla, n. sp			*		
" (Haminea) Aldrichi, Langdon	*		*		
Scaphander, n. sp			*		
Tornatina? sp	*				
Odostomia, sp	*				
Chemnitzia trigemmata, Con			*		
" n. sp			*		
Eulima notata, Lea			*		
" ? sp			*		
Melanopsis, n. sp			*		
" anita, Aldr			*		
Ringicula, sp	*				
Cytherea Nuttalliopsis, Heilpr	*	*	*		*
" perovata, Con.	*				
Ostrea compressirostra, Say	*				
" sp.?	*		*		
Pecten, n. sp	*				
" Deshayesii, Lea			*	*	
Cardium Nicolleti, var			*		
Modiola, sp.			*		
Avicula limula, Con			*		
Crassatella tumidula, Whitf	*		*		
" sp.			*	*	
Dosinopsis lenticularis, Rogers	*				
Lucina compressa, Lea	*				
" pomilia, Con	*				
" Claibornensis, Con			*		
" sp			*		
Diplodonta, sp			*		
Tellina, 4 sp			*		
Arca lima, Con., var	*		*		
Cucullæa transversa, Rogers		*	*		
Venericordia planicosta, Lam	*		*		*
" rotunda, Lea., var	*		*	*	*
Pectunculus stamineus, Con	*	*	*	*	
" " var	*				
Pholas alatoidea, Aldr	*		*		*
Egeria inflata, Lea	*				
" plana? Lea	*		*		*
" subtrigonia, Lea	*				
" rotunda, Lea		*		*	
Leda protexta, Con	*	*	*	*	
" sp			*	*	*

	Bell's Upper.	Bell's Lower.	Gregg's Landing, Marl.	Lower Peach Tree.	Tuscahoma Landing.
Martesia elongata, Aldr.	*				
Panopæa, sp.			*		*
Lithodomus Claibornensis, Con.	*				
Corbula engonata, Con.	*		*	*	*
“ n. sp.	*				
“ Aldrichi, Mr.			*		*
Nucula magnifica, Con.	*		*		
Cyclosmilia, sp.	*	*	*	*	*
Massive Coral		*	*	*	
Nodosaria, sp.	*			*	

TABLE VII.

NANAFALIA GROUP.

The most remarkable fossil of this division is *Gryphæa thirsæ*, Gabb., which is abundant through sixty feet of strata. The best location for its fossils is near the base under the *Gryphæa* bed. As nearly all the specimens on hand are from the exposures on the Tombigbee River, no other localities are mentioned.

Turritella Mortoni, Con.
“ bellifera, Aldr.
“ n. sp.
Pseudoliva vetusta, Con.
“ scalina, Heilpr.
“ erecta, Aldr.
Ancillaria subglobosa, Con.
“ n. sp.
Rostellaria trinodifera, Con.
Voluta Sayana, Con.
“ Newcombiana, Whitf.
“ (Athleta) Tuomeyi, Con.
Volutalithes, sp.
Fusus trabeatus, Con.
“ n. sp.
“ sp.
Exilia pergracilis, Con.
Pleurotoma, sp.
“ persa, Whitf.
“ sp.
“ terebralis, Lam.
Natica eminula, Con.
“ ætites, Con.
Dentalium thalloides, Con.
Dentalium sp. (smooth).
Cadulus, sp. ———
Melanopsis Choctawensis, Aldr.
“ n. sp.
Ringicula, n. sp.
Odostomia, sp.
Bulla, sp.

Venericardia planicosta, Lam.
Gryphæa thirsæ, Gabb.
Pectunculus stamineus, Con.
Crassatella tumidula, Whitf.
Panopæa, sp.
Arca, n. sp.
Cardium Tuomeyi, Aldr.
Corbula Aldrichi, Mr.
Tellina, sp.
Nucula ovula, Lea.
Leda, sp.
Cytherea Nuttalliopsis, Heilpr.
Pinna, sp.
Ostrea compressirostra, Say.

Cyclosmilia? sp.

TABLE VIII.

MATTHEWS' LANDING GROUP.

The exposure from which this collection was made is on the Alabama River, about seven miles below Prairie Bluff. One other point in Wilcox County, on Mr. Jones' place (S. 12, T. 12, R. 6 E.), has the identical fossils. The list is made from the typical deposit. Nearly all the univalves are remarkable for their ornamentation. *Rostellaria velata*, Con., absent from all the other groups below the "Claibornian," appears once more here.

Murex morulus, Con.
" Matthewsensis, Aldr.
Triton Showalteri, Con.
? " n. sp.
Strepsidura, sp.
Fusus tortilis, Whitf.
" Meyeri, Aldr.
" 6 species.
" pagodiformis, Heilpr.
Exilia pergracilis, Con.
Neptunea Matthewsensis, Aldr.
Leucozonia biplicata, Aldr.
Pleurotoma persa, Whitf.
" adeona, Whitf.
" 12 species.
Trochus Alabamensis, Aldr.
Solarium, sp.
" n. sp.
Pseudoliva unicarinata, Aldr.
" vetusta, Con.
" scalina, Heilpr.
Ancillaria staminea, Con.
Rostellaria velata, Con.
Pyrula juvenis, Whitf.
Volutalithes limopsis, Con.
" rugata, Con.
Voluta Showalteri, Aldr.
Lævibuccinum lineatum, Heilpr.
Natica perspecta; Whitf.
" reversa, Whitf.
" Alabamensis, Whitf.
Natica eminula, Con.
" n. sp.
Sigaretus? n. sp.
Melanopsis Choctawensis, Aldr.
Cadulus turgidus, Mr.
Dentalium microstria, Heilpr.
Cerithiopsis, n. sp.
Odostomia, sp.
Eulima, sp.
Rissoina, n. sp.
Ringicula, n. sp.
Cylichna, sp.
Turritella humerosa? Con.
" Alabamensis, Whitf.
" multilira, Whitf.
" Mortoni, Con.

Cucullæa macrodonta, Whitf.
Pecten (Pleuronectia) Alabamensis, Aldr.
Venericardia rotunda, Lea, var.
" Sillimani, Lea.
Corbula, sp.
Leda eborea, Con.
Nucula magnifica, Con.
Cardium, sp.
Avicula limula, Con.
Astarte, sp.

Nodosaria, sp.
Coral, sp.

TABLE IX.

BLACK BLUFF GROUP.

This bed consists principally of a bed of very dark clay, which has a fine exposure on the Tombigbee River at Black Bluff, Sumpter County, and I believe is the lowest Tertiary seen on that river. It forms a belt of low-lying prairie just south of the Cretaceous hills.

Its fossils would unite it to the Matthews' Landing group.

Nautilus, n. sp. (fragments).
Exilia pergracilis, Con.
Mitra, n. sp.
Aphorais gracilis, Aldr.
Ancillaria, sp.
Pleurotoma, 2 sp.
Fusus, 2 sp.
Cadulus turgidus, Mr.
Volutalithes rugata, Con.
Dentalium, sp.

Tornatella bella, Con.

Pecten (Pleuronectia) Alabamensis, Aldr.
Cucullæa macrodonta, Whitf.
Nucula magnifica, Con.
Leda, n. sp.

Coral, sp.
Crab remains (abundant).
Foraminifera, 2 sp.

TABLE X.

MIDWAY GROUP.

Consists of a few feet of material at the base of the Tertiary; a bed containing a species of Turritella being immediately contiguous to the Cretaceous. The fossils of this and the previous group are either distorted or badly preserved, and by weathering of the materials often mixed with the underlying Cretaceous. The species here mentioned were all found "in *situ*."

1st. MIDWAY BED consisting of a hard, silicious limestone.

Enclimatoceras Hyatti? White.

2d. TURRITELLA ROCK.

Turritella Mortoni? Con.
" humerosa? Con.
Venericardia planicosta, Lam.

Ostrea, 2 sp.
Coral, 2 sp.

In conclusion, it must be understood that these lists represent collections made personally in company with Dr. E. A. Smith and D. W. Langdon, Jr., and are as nearly accurate as the writer can make them, without a series of fossils carefully compared with types; they represent many days and nights of hard work.

FINIS.

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Fig. 14. Cerithium Langdoni, n. sp.,	34
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Fig. 16. Pleurotoma Americana, n. sp.,	29
Fig. 17 *a b*. Fusus Pearlensis, n. sp.,	21
Fig. 18. Scalaria Whitfieldi, n. sp.,	34
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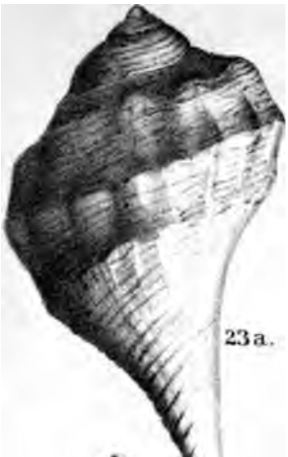
Fig. 21. Cassidaria dubia, n. sp.,	33
Fig. 22. Scalaria octolineata, Conrad.,	34
Fig. 23 *a*. Pyrula (Pyrificus) Smithii, Sowb., (from Europe),	24
b. Fulgur triserialis, Whitf.,	24

Plate 1.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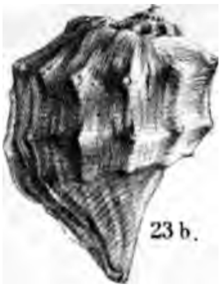
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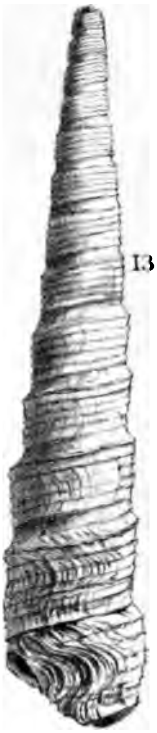
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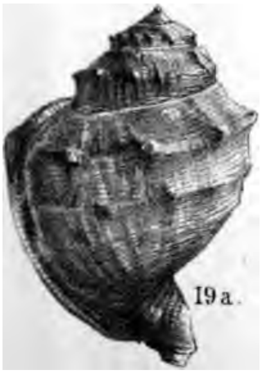
17 a.

17 b.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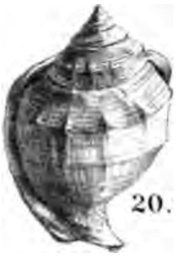
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THE KREBS LITHOGRAPHING CO.

Explanation of Plate II.

		PAGE.
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Fig. 3.	**Pleurotoma anita, n. sp.,**	**29**
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Fig. 9.	**Phos Vicksburgensis, n. sp.,**	**27**
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Fig. 11.	**Conus (Conorbis) alatoideus, n. sp.,**	**32**
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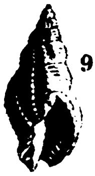
Plate 2.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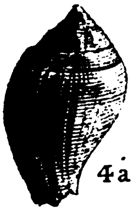
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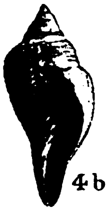
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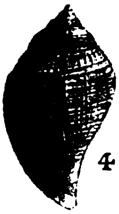
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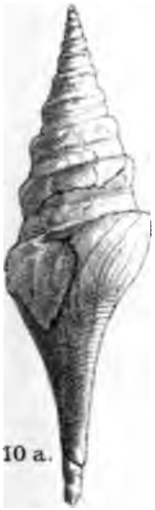
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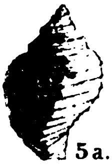
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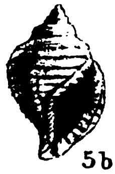
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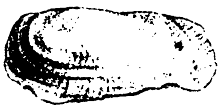
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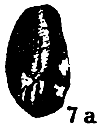
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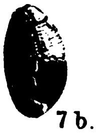
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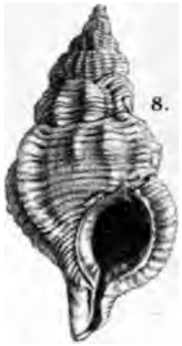
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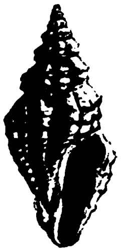
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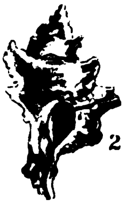
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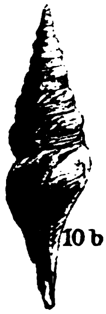
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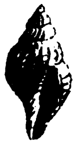
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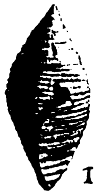
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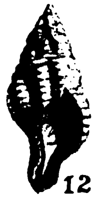
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THE KREBS LITHOGRAPHING

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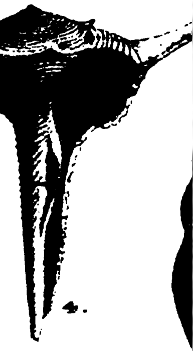
Fig. 5.	**Neptunea enterogramma, Gabb.,**	24
Fig. 6 *a b*.	**Cominella Hatchetigbeensis, n. sp.,**	26
Fig. 7.	**Cerithium Tombigbeense, n. sp.,**	34
Fig. 8.	**Melanopsis Choctavensis, n. sp.,**	35
Fig. 9.	**Pleurotoma exilloides, n. sp.,**	30
Fig. 10.	**Pleurotoma Tombigbeensis, n. sp.,**	30
Fig. 11.	**Pleurotoma Tuomeyi, n. sp.,**	31
Fig. 12.	**Fusus Meyeri, n. sp.,**	21
Fig. 13.	**Pisania? dubia, n. sp.,**	25
Fig. 14.	**Voluta Showalteri, n. sp.,**	28
Fig. 15.	**Murex Matthewsensis, n. sp.,**	18
Fig. 16, *a*.	**Buccinum Mohri, n. sp.,**	26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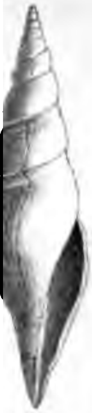
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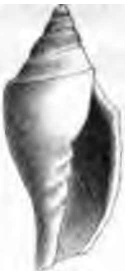
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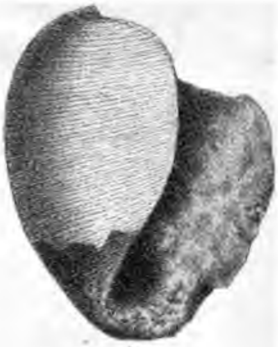
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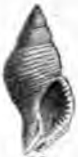
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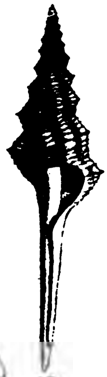
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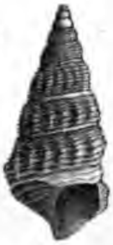
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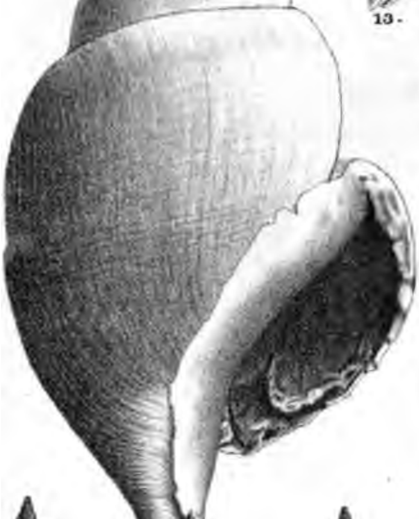
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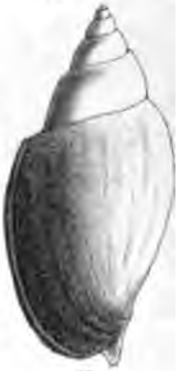
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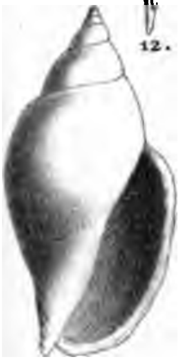
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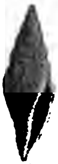
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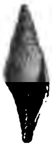
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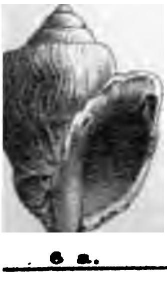
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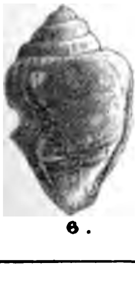
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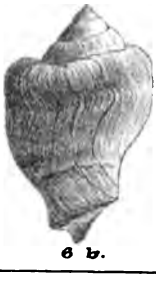
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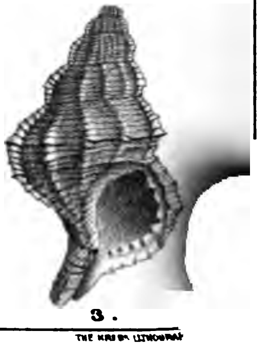
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*Fig. 9 *b c*. Pholas alatoidea, n. sp.,	36
Fig. 10 *a b*. Martesia elongata, n. sp.,	37
Fig. 11 *a*. Cucullæa transversa, Rogers,	40
Fig. 12 *a b*. Cardium Hatchetigbeense, n. sp.,	39
Fig. 13. Cardium Tuomeyi, n. sp.,	40

By mistake of the lithographers this figure is numbered 4' instead of 9.

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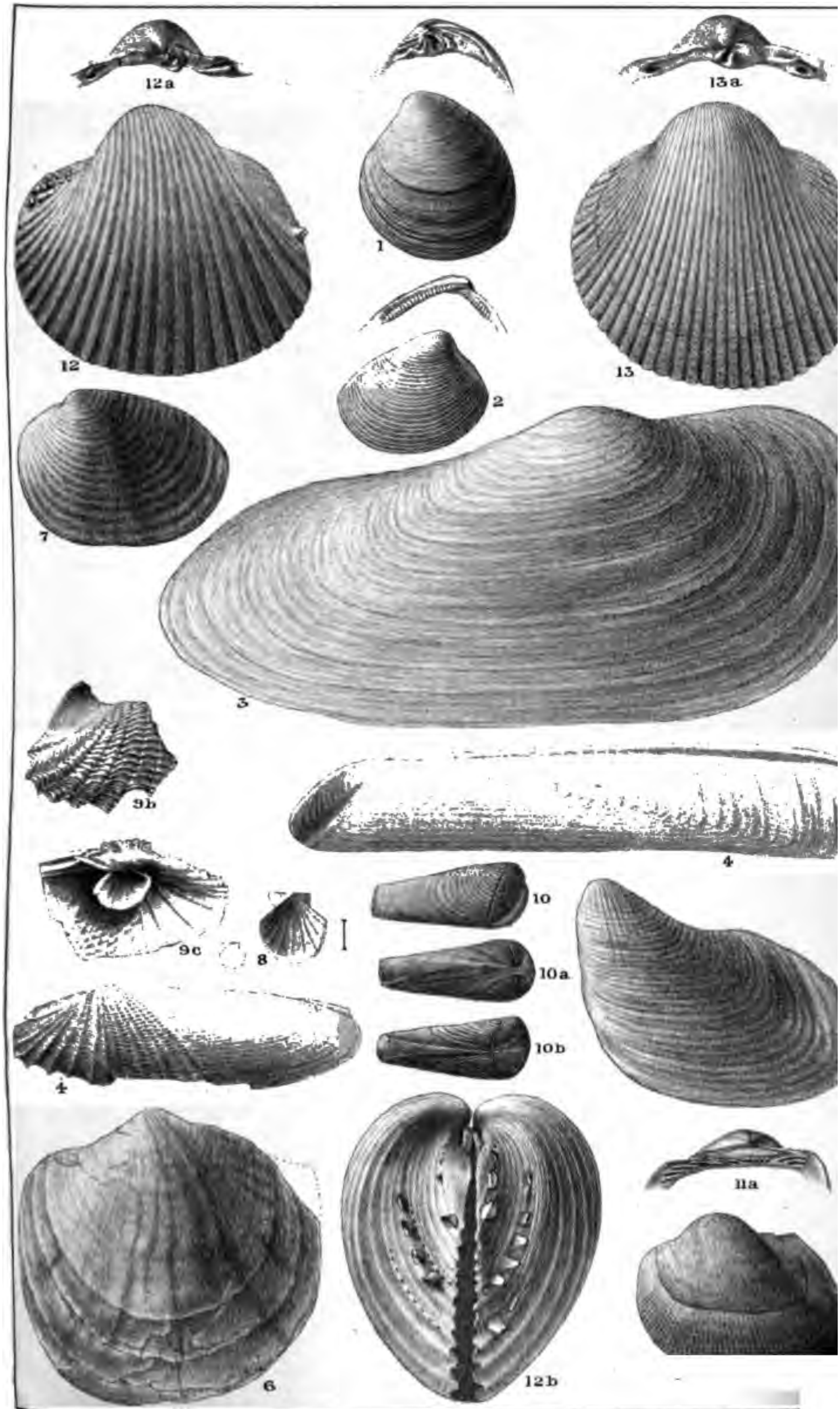

Explanation of Plate V.

		PAGE.
Fig. 1.	**Expleritoma prima, nov. gen et sp.,**	29
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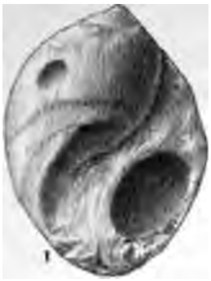
Fig. 3.	**Cypræa Smithii, n. sp.,**	33
Fig. 4.	**Cominella striata, n. sp.,**	26
Fig. 5.	**Nassa Calli, n. sp.,**	27
Fig. 6.	**Trophon gracilis, n. sp.,**	19
Fig. 7.	**Fusus Tombigbeensis, n. sp.,**	22
Fig. 8.	**Murex simplex, n. sp.,**	19
Fig. 9.	**Fusus rugatus, n. sp.,**	22
Fig. 10.	**Natica recurva, n. sp.,**	33
Fig. 11.	**Ancillaria expansa, n. sp.,**	28
Fig. 12.	**Melanopsis anita, n. sp.,**	35
Fig. 13.	**Neptunea constricta, n. sp.,**	24
Fig. 14.	**Aphorais gracilis, n. sp.,**	32
Fig. 15.	**Leucozonia biplicata, n. sp.**	23
Fig. 16.	**Trochus Alabamensis, n. sp.,**	35
Fig. 17.	**Pseudoliva unicarinata, n. sp.,**	19
Fig. 18.	**Fasciolaria pergracilis, n. sp.,**	22

Pl. 5.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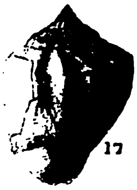
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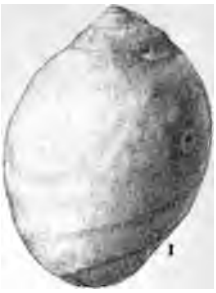
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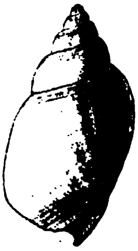
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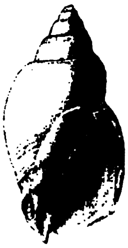

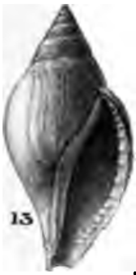
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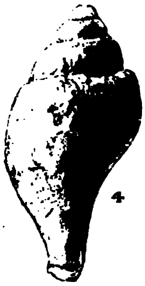
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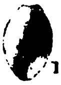
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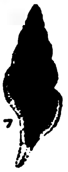
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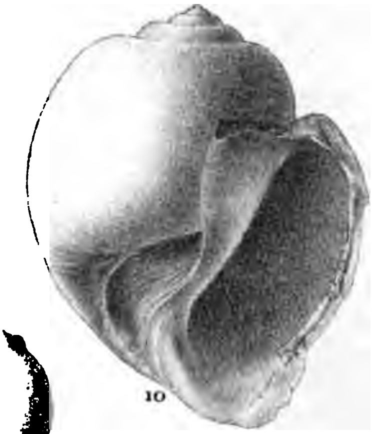
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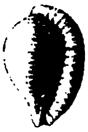
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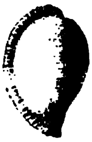

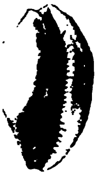
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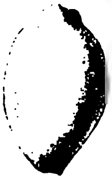

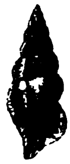
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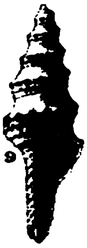
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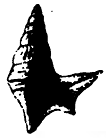
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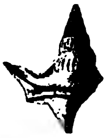

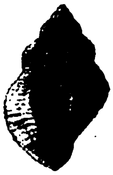
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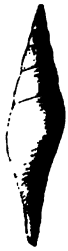
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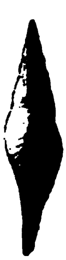

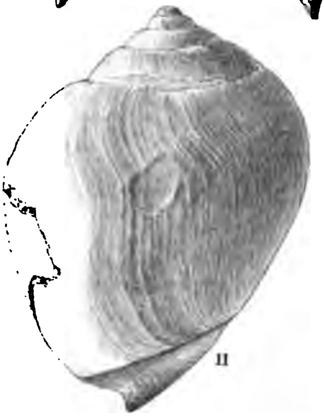
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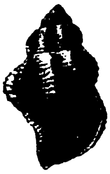
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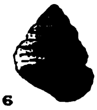

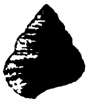

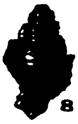
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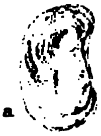
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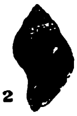
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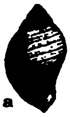
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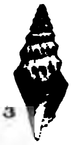
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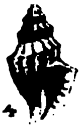
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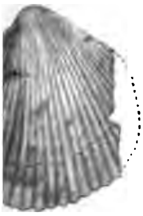

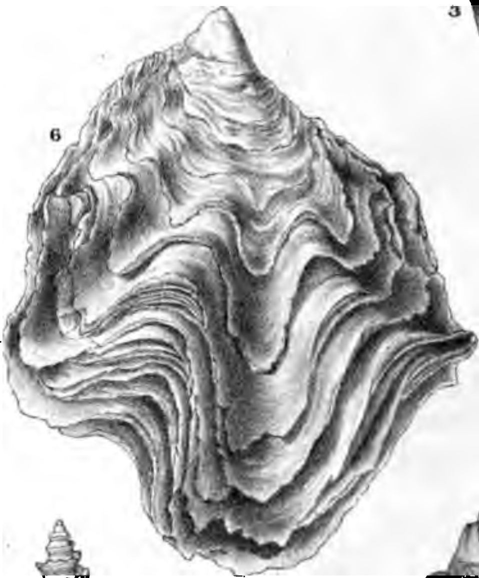
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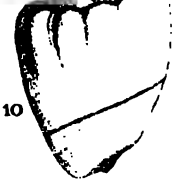
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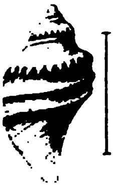

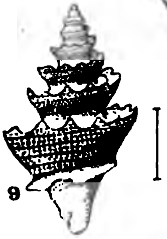
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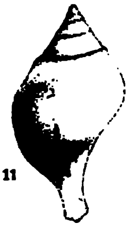
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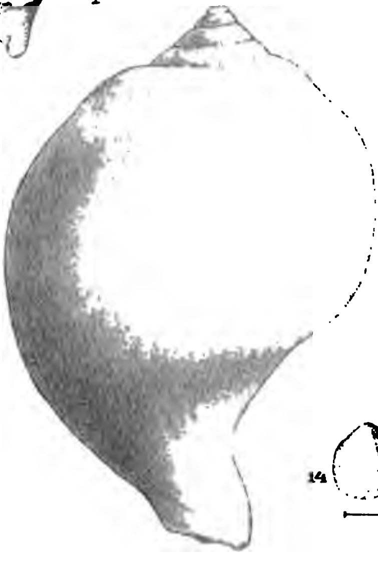
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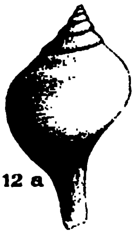
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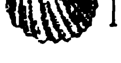
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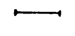
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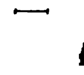
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II.

CONTRIBUTIONS

TO THE

Eocene Paleontology of Alabama and Mississippi.

BY

OTTO MEYER, Ph. D.

Contributions to the Eocene Paleontology of Alabama and Mississippi.

BY OTTO MEYER, PH. D.

In the following a number of new or unfigured species of invertebrates of the Eocene Tertiary of Alabama and Mississippi are described and figured. A very few known species are refigured for some special reason. Those descriptions and figures which belong to Plate I were made in the year 1884, but the publication of this plate has been delayed by various reasons. I am under obligation to Mr. T. H. Aldrich and Dr. E. A. Smith for the present opportunity to publish this paper. The type specimens are in my collection. In the following descriptions of univalves, the term "longitudinal" means parallel to the suture or helicoid axis of the shell, "transverse" indicates the direction rectangular to it.

DENTALIUM LEAI MEYER. Pl. 1, figs. 2, 2a. *Am. Jour. Sci.*, 1885, XXIX., p. 462.

?Dentalium arciformis, Con. *Am. Jour. Sci.*, I, 2d ser., 1846, p. 212. Pl. 1, fig. 3.

Substance of the shell thick, slightly curved, smooth; section and aperture circular; smaller termination notched in the direction of the curvature; interiorly with a tube.

Locality.—Claiborne, Ala.

Three specimens have the incision of the smaller termination, but only one of them is perfect enough to show the interior tube also. A young specimen approaches in its aperture the following species:

The smooth species of Dentalium have to be distinguished by their aperture. The aperture is wanting in Conrad's specimen of *Dentalium arciformis.* Later, Conrad withdrew this species; at least he did not mention it in his lists, probably considering his form a synonym of *Dentalium turritum*, Lea,[*] which species, however, in my opinion, is a fragment of a Cadulus.

Dentalium Danai, Meyer. Pl. 3, figs. 2, 2a. *Am. Jour. Sci.*, 1885, XXIX., p. 462.

Smooth, section circular; smaller aperture with additional tube; margin distinctly notched on the convex side of the shell; slightly emarginate on the concave side

Locality.—Jackson, Miss.

The preceding species is notched distinctly on both sides of the margin of the aperture.

Dentalium subcompressum, Meyer. Pl. 3, figs. 3, 3a. *Am. Jour. Sci.*, 1885, XXIX., p. 462.

Shell small, smooth, somewhat polished; section ovate.

Locality.—Jackson, Red Bluff, and Vicksburg, Miss.

The figured type-specimen is from Jackson.

Dentalium bitubatum, n. sp. pl. 3, fig. 1.

Smooth, rapidly increasing in size; section suborbicular; aperture with a long additional tube.

Locality.—Jackson, Miss.

I have only one specimen of this species, which in its long tube of the aperture resembles *Dentalium duplex*, Def.[†] from the Paris basin.

Dentalium annulatum, n. sp. Pl. 1, fig. 1.

Small. slightly tapering; section circular; surface annulated.

Locality.—Claiborne, Ala.

I found only the figured specimen. Without a magnifying glass the characteristic rings of the surface are scarcely to be seen. It is very similar to young specimens of *Dentalium minutistriatum*, Gabb.,[‡] which species is annulated on its youngest part, a fact not mentioned by Gabb.

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[*] I. Lea, *Contrib. to Geol.*, 1833, p. 35, pl. 1, fig. 3.

[†] Desh., An. s. vertèb., II., p. 203, pl. 1, figs. 36–39.

[‡] *Jour. Acad. Nat. Sci.*, Phila., IV., 2d ser., 1860, p. 386, plate 67, fig. 46.

In the Claiborne specimen, however, the rings are larger and of a different appearance, and there is no trace of longitudinal striæ.

CADULUS VICKSBURGENSIS, Meyer. Pl. 3, fig. 6. *Am. Jour. Sci.*, XXIX., 1885, p. 463.

Inflation very faint near the end, somewhat compressed; smaller aperture with four turret-like appendages, one opposite pair of which is broader than the other pair.

Locality.—Vicksburg, Red Bluff, Miss.

The type specimen is of the "Higher Vicksburgian." The species is distinctly compressed, but less than Cadulus depressus, Mr., from Claiborne.

CADULUS QUADRITURRITUS, n. sp. Pl. 3, figs. 7, 7a.

Not compressed; inflation near the end distinct but gradual; smaller aperture with four equal rounded appendages, divided by notches of the same shape.

Locality.—Red Bluff, Miss.

CADULUS JACKSONENSIS, Meyer. Pl. 3, figs. 8, 8a, 8b. *Am. Jour. Sci.*, XXIX., 1885, p. 462.

Rather large; inflation faint near the end, very slightly compressed; smaller aperture elliptical; margin by notches divided into four appendages; the two appendages on the smaller side of the ellipse are slender, simple and equal to each other; the two other opposite ones are broad, emarginate in the middle, and unequal in size, that one situated on the convex side of the shell being the largest.

Locality.—Jackson, Miss.

CADULUS TURGIDUS, n. sp. Pl. 1, fig. 10.

Width of the shell rapidly increasing for about two-thirds of the entire length, and then more rapidly decreasing; section circular.

Locality.—Matthews' Landing, Ala.

Rather common; I received this shell from Mr. Aldrich. It differs by its very strong inflation from all the other species of Cadulus of the Southern Tertiary which I know of.

Cadulus corpulentus, n. sp. Pl. 3, fig. 5.

Small; inflation near the middle, short and stout, not compressed; smaller aperture elliptical with simple margin.

Locality.—Red Bluff, Miss.; common.

Cadulus juvenis, n. sp. Pl. 3, fig. 4.

Small; inflation near the middle; slender, not compressed; smaller aperture forming an ellipse, one side of which is flattened.

Locality.—Jackson, Miss.; not rare.

Teinostoma angularis, Meyer. Pl. 1, figs. 9, 9a. *Am. Jour. Sci.*, 1885, XXIX., p. 463.

Lenticular; whorls three, rapidly increasing in size, last whorl carinated; base slightly convex, nearly flat; columellar part thickened; mouth rhombical. On both sides of the carina several impressed spiral lines crossed by very minute radiating striæ. Last whorl with an indistinct spiral fold near the suture.

Locality.—Claiborne, Ala.

Teinostoma subrotunda, Meyer. Pl. 2, figs. 26, 26a. *Am. Jour. Sci.*, 1885, XXIX., p. 463.

Discoid; margin rounded; umbilical region covered and thickened by callus; whorls four, rapidly increasing in size; smooth, except some faint revolving lines; suture indistinct; aperture quadrate-elliptical.

Locality.—Claiborne, Ala.

Teinostoma Verrilli, Meyer. Pl. 2, figs. 27, 27a. *Am. Jour. Sci.*, 1885, XXIX., p. 463.

Discoid; umbilical region covered and thickened by callus; margin angular, though not carinated, polished; suture entirely indistinct, so that the number of whorls can not be counted; base regularly rounded; aperture trigonal-elliptical.

Locality.—Jackson, Miss.

Related to the preceding species, but distinguished by the more angular margin, and the entire absence of sculpture. The first difference implies also the different form of base and aperture; the second difference, the indistinctness of the suture.

ADEORBIS SUBANGULATUS, n. sp. Pl. 2, fig. 28.

Discoid; whorls five, rapidly increasing in size; margin somewhat angular; basal part of margin rounded; umbilicus deep; suture distinct; surface with revolving lines, indistinct near the margin; aperture irregularly elliptical.

Locality.—Jackson, Miss.

Adeorbis depressus, Lea., sp. (Teinostoma rotula, Heilpr.) from Claiborne has the umbilicus nearly closed, a regularly rounded margin, a more developed ornamentation, and is larger.

ADEORBIS LAEVIS, n. sp. Pl. 2, figs. 29, 29a.

Discoid; umbilicus large; margin rounded; aperture circular; whorls five; convex, smooth; suture distinct.

Locality.—Red Bluff, Miss.

In Vicksburg there occurs a variety "var Vicksburgensis," with smaller umbilicus.

SOLARIUM HARGERI, n. sp. Pl. 2, figs. 23, 23a, 23b.

Discoid; surface flattened; base convex; margin carinated; whorls five. The ornamentation of the older whorls consists of four granulated revolving striae, the two in the middle smaller than those near the suture. Suture canaliculated; base with revolving lines, those near the umbilicus crenulate; aperture rhombical.

Locality.—Red Bluff, Miss.

The canaliculation along the suture is the main characteristic of this species. Named in honor of Mr. Oscar Harger, the able and careful naturalist in New Haven, Conn.

SCALARIA GRACILIOR, n. sp. Pl. 2, fig. 2.

Small, subulate; nucleus consisting of two rounded, spirally striated whorls. Five adult whorls are regularly rounded and covered with regular, sharp, transverse ribs, which extend also over the base. Aperture elliptical.

Locality.—Claiborne, Ala.

I found only the figured specimen.

EGLISIA PULCHRA, n. sp. Pl. 1, fig. 16.

Whorls convex, regularly rounded, covered with five flat longitudinal lines, diminishing in breadth from the top to the base of each whorl. They are crossed by numerous fine elevated striæ, which are broad and indistinct, or obsolete on the spiral lines, but sharp and distinct in the interstices.

Locality.—Claiborne, Ala.

In its sculpture the species is remarkably similar to *Scalaria* (*Eglisia*) *vincta*, Desh.,* but it is much larger.

EGLISIA REGULARIS, n. sp. Pl. 2, fig. 3.

Whorls rather rapidly increasing in size, regularly rounded; covered by four sharp elevated revolving lines, the uppermost of which is the smallest; the interstices with numerous transverse riblets, which in connection with the revolving lines give to the surface an almost cancellate appearance.

Locality.—Red Bluff, Miss.

EGLISIA INAEQUISTRIATA, n. sp. Pl. 2, fig. 4.

The only specimen found, a fragment of two whorls, has less rounded whorls than the preceding species; they are covered by six revolving striæ, alternating in size and far less elevated than in *Eglisia regularis;* the little riblets in the interstices are similar to those in the preceding species; aperture rounded; subeffuse anteriorly; base flattened, spirally striated.

Locality.—Red Bluff, Miss.

CÆCUM SOLITARIUM, n. sp. Pl. 3, fig. 9.

Cæcum, sp., *Am. Jour. Sci.*, XXX., 1885, p. 71.

Small, regularly curved, somewhat contracted at the aperture; section and aperture circular; smooth, except concentric rings of growth.

Locality.—Vicksburg, Miss.; "Lower Vicksburgian."

CRUCIBULUM ANTIQUUM, n. sp. Pl. 1, fig. 11.

Subconical; margin oval, striate within; diaphragm entire; rhombical, close to the shell.

Locality.—Claiborne, Ala.

The surface of the single specimen is badly preserved. If I am not mistaken it is the first Crucibulum found in the Old Tertiary Formation.

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*Desh., An. s. vertèb., II., p. 353, pl. 23, figs. 17, 18, 19.

Natica decipiens, Meyer. Pl. 2, fig. 22. *Am. Jour. Sci.*, XXIX., 1885, p. 464.

Spire rather elevated; whorls six, flattened; aperture semilunar, two-thirds of the entire length; umbilicus deep; on the inner lip callus is spread, which forms a prominence at the posterior end of the aperture; inner lip distinctly emarginate in front of the umbilicus.

Locality.—Vicksburg, Miss.

It has a more transverse form than *Natica parva*, Lea., from Claiborne, which is else very similar. The type-specimen is from the "Lower Vickburgian"; but it occurs also in the "Higher Vicksburgian."

Amaura tornatelloides, n. sp. Pl. 1, fig. 12.

Shell oval; imperforate, smooth; spire conical; apex obtuse; suture very distinct; whorls five; columella thickened; aperture semicircular, acute posteriorly, and with an indistinct broad emargination anteriorly.

Locality.—Claiborne, Ala.

I found only the figured specimen.

Rissoina Mississippiensis, n. sp. Pl. 2, fig. 17.

The only specimen found has four smooth, embryonic whorls; the first two of which form a disk, thus making the apex blunt; then four adult whorls follow which are slightly convex, and are densely covered by indistinct, rounded, oblique, transverse ribs; base with faint revolving lines; aperture semilunar, faintly channeled anteriorly; receding posteriorly, thus giving a strongly sigmoid appearance to the outer lip.

Locality.—Jackson, Miss.

Aclis modesta, n. sp. Pl. 2, fig. 1.

Minute; the sinistral nearly vertical; nucleus consists of two smooth whorls: adult whorls five; little convex; flattened immediately below the suture; covered with microscopical spiral lines; aperture regularly elliptical.

Locality.—Claiborne, Ala.

Only the type-specimen was found.

Turbonilla neglecta, n. sp. Pl. 1, fig. 4.

Subulate; whorls flattened, closely covered with broad and distinct transverse ribs, ending rather abruptly on the last whorl and leaving the base smooth; aperture subquadrangular, longer than broad; inner lip twisted, thus forming an obtuse fold at some distance from the sharp outer lip; crenulate within by a few distant elevated spiral lines.

Locality.—Claiborne, Ala.

TURBONILLA MISSISSIPPIENSIS, n. sp. Pl. 2, fig. 5.

Subulate; the sinistral nucleus consists of three smooth convex whorls, which very rapidly increase in size: its axis is horizontal. Seven convex adult whorls are covered with elevated, tranverse ribs, about twelve on each whorl. Suture distinct, aperture oval, base smooth.

Locality.—Red Bluff, Miss.

Differs from the preceding species mainly by its convex whorls.

ODOSTOMIA BIDENTATA, n. sp. Pl. 1, fig. 3.

Subulate, whorls eight; nucleus and first whorl smooth, elsewhere furnished with transverse ribs; suture impressed; base rounded, smooth; columella with a very prominent oblique fold, and a second indistinct one below it.

Locality.—Claiborne, Ala.

The ribs have in one of the three specimens a tendency to become obsolete, especially toward the lower part of each whorl. The lower fold will be better seen in fragments, with exposed columella, than in a perfect mouth.

CHEMNITZIA ACUTA, n. sp. Pl. 2, fig. 6.

Whorls eleven, nearly flat; aperture ovate The ornamentation consists of sharp, transverse ribs, crossed by less prominent spiral lines. Each of the four smooth, embryonic whorls is much smaller than the first ornamented whorl, thus forming a pointed nucleus; suture distinct.

Locality.—Red Bluff, Miss.

Chemnitzia Clairbornensis, Heilpr., sp.,[*] has the revolving lines not elevated, but impressed; and the transverse ribs are not sharp lines, but obtuse folds.

BITTIUM KŒNENI, n. sp. Pl. 2, fig. 12.

Four spirally striated, embryonic whorls without ribs are followed by four transversely ribbed whorls with three spirals, the uppermost of which is the smallest. On the following older whorls, three more spirals appear between them. All the whorls are convex; aperture effuse anteriorly, but without proper canal; base spirally striated. Many of the specimens have varices.

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[*] *Proc. Ac. Nat. Sci.*, Philadelphia, 1879; p. 214, pl. 13, fig. 11.

Localities.—Jackson, Miss., common; Red Bluff, Miss., not rare.

The type-specimen is from Jackson; in the specimens from Red Bluff the canal is more distinct. Named after Prof. v. Kœnen, who has successfully worked up the German Tertiary.

CERITHIOPSIS ALDRICHI, n. sp. Pl. 2, fig. 14.

Subulate; whorls convex; oldest whorls covered by four spiral lines, the second one from above is the smallest and last developed one; they are covered by transverse ribs, about twelve on each whorl; the embryonic whorls are numerous and rounded—on the oldest of them the spiral lines commence to appear, while the others are only covered by numerous curved, transverse ribs. Base covered with minute elevated, revolving lines, the outermost of which is larger; canal reflected.

Localities.—Red Bluff, Miss., Jackson, Miss., Claiborne, Ala.

CERITHIOPSIS JACKSONENSIS, n. sp.

Whorls regularly rounded, covered by four elevated, longitudinal lines, crossed by numerous transverse ribs of smaller size; the points of crossing are thickened. Base covered with minute elevated, revolving lines, the outermost of which is larger; canal reflected.

Locality.—Jackson, Miss.

On the last whorl of the type-specimen a fifth spiral line appears near the suture, and in a much larger specimen this fifth spiral is fully developed. Differs from the preceding species in having more rounded whorls.

TRIFORIS SIMILIS, n. sp. Pl. 1, figs. 8, 8a.

Slender; whorls flat, covered with three longitudinal lines of nodules; the middle line the smallest and apparently last developed, but on the lower whorls equal in size to the other two; mouth quadrate; base flattened, with a distinct impressed line along its margin; suture very distinct. Length of the last five whorls, three mm.

Locality.—Claiborne, Ala.

The species is very similar to the Miocene *Cerithium moniliferum*, H. C. Lea,* which I do not have. Besides, it resembles very much that

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**Trans. Am. Philos. Soc.*, IX., Second Series, 1843, p. 269, pl. 37, fig. 92; and Emmons' *Rep. North Carolina Geol. Surv.*, p. 269, fig. 159.

species of the German Oligocene of Waldbœckelheim, which had been considered as the recent *Triforis perversus*, L., but which v. Kœnen calls *Cerithium Bœttgeri*.* I am of the opinion that this German form is a true *Triforis*. One of my larger specimens, with an outer lip more complete than is commonly the rule, has the canal nearly closed. The absence of a third opening is no absolute proof, as some recent sure species of *Triforis* (for instance, *Trif. nigro-cinctum*, Ad., of the American Coast) usually do not show it. The number of spiral lines on the base of this German species is variable, depending mainly, but not alone, upon the size of the shell. A few of the largest specimens are distinguished by a fourth line of nodules on the last whorls.

TRIFORIS MAJOR, n. sp. Pl. 1, fig. 6.

Large; whorls flat, lower whorls with three longitudinal lines, formed by nodules of equal number in each line; the nodules of the uppermost spiral are the largest and touch nearly those of the middle line; they are rounded and separate from each other; those of the two lower spirals are compressed; the middle is the smallest and apparently last developed; base flattened, with a distinct impressed line along its margin; length of the two lower whorls, five mm.

Locality.—Claiborne, Ala.

TRIFORIS MERIDIONALIS, n. sp. Pl. 2, fig. 15.

Large; whorls flat, with three longitudinal lines, which are continuous and only faintly nodulus—the lowest is the largest, the middle line is only one-third and the uppermost two-thirds of its breadth; the suture is defined by one more small, elevated line; base with a revolving line along the suture.

Locality.—Red Bluff, Miss.

TRIFORIS, sp. Pl. 1, fig. 7.

Small; whorls flat, with three noduliferous spiral lines, the middle of which is the smallest; of these lines, especially the uppermost one is sometimes broken up in single nodules, but in general they are continuous; base with radial lines of growth and a spiral along its margin.

Locality.—Claiborne, Ala.

Resembles the preceding species.

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* v. Kœnen, *Norddeutsch. Miocæn.*, *Zweiter Theil; N. Jahrb. f. Mineralogie*, etc., 1882, Beilageband II., p. 272.

TRIFORIS DISTINCTUS, n. sp. Pl. 1, figs. 5, 5a.

Small, slender; whorls convex, with three noduliferous, longitudinal lines, the uppermost of which is the smallest; suture marked by a small, plain, elevated spiral line; mouth subquadrate; base with a distinct and an indistinct spiral line; length of the five lower whorls, two and one-half mm.

Locality.—Claiborne, Ala.

The species is very distinct from the preceding in its convex whorls and in the line along the suture. Owing to the lowest spiral, the whorls appear almost carinated at their lowest part. An essential characteristic is in the upper line being the smallest and apparently last developed, the species resembling, in this point, the German Tertiary *Cerithium* (*Triforis*) *Fritschi*, v. Kœnen.*

TRIFORIS BILINEATUS, n. sp. Pl. 2, fig. 16.

Small; whorls flat, with two lines of separate, rounded nodules; base with a revolving line near the suture.

Locality.—Red Bluff, Miss.

Differs from all the preceding species by having only two revolving lines. As the distance of the lines is about equal, the shell looks like being uniformly covered with spirals, and the whorls can scarcely be distinguished from each other.

NASSA MISSISSIPPIENSIS, Con., sp. var. Pl. 2, fig. 11.

Besides the typical form, there occurs both in the Higher and Lower Vicksburgian, but is rare, a variety with more numerous transverse ribs.

CANCILLARIA TURRITISSIMA, n. sp. Pl. 1, fig. 15.

Turreted; the convex whorls very oblique to the axis of the shell; apex obtuse, smooth, the shell otherwise covered with numerous spiral lines, crossed by some transverse, large ribs; aperture semicircular; columella with three folds—the uppermost very prominent, the lowest indistinct; outer lip sharp, striate within at some distance from the aperture.

Locality.—Claiborne, Ala.

The first two embryonic whorls form almost a disk, thus making the apex obtuse. A species similarly distinguished by its very slender form is *Cancellaria Bezanconi*, de Boury,* from the French Tertiary.

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* *N. Jahrb. f. Mineralogie*, etc., 1882, Beilageband II., p. 271, pl. 6, fig. 19.

LATIRUS HUMILIOR, Meyer. Pl. 2, figs. 20, 20a.

Turbinella humilior, Meyer. *Am. Jour. Sci.*, XXIX., 1885, p. 464.

Fasciolaria Jacksonensis, Aldrich. *Jour. Cin. Soc. Nat. Hist.*, 1885, p. 150, pl. 2, fig. 12.

Fig. 20 represents my oldest specimen; its canal is somewhat shorter than usual. Fig. 20a is a young specimen. Fig. 19 shows, for comparison, *Latirus protracta*, Con., sp., from Vicksburg. I refer to the above-cited place.

MUREX ANGULATUS, n. sp. Pl. 2, fig. 18.

Ovate; nucleus consisting of four smooth, embryonic, rounded whorls, which rapidly increase in size; adult whorls angular, with edged, transverse ribs, which, on the angles, are produced into spines—on the body whorl they number ten; a few distinct, elevated, revolving lines cover the lower part of each whorl; canal slightly curved.

Locality.—Jackson, Miss.

MUREX SIMPLEX, Aldr., var.; *aspinosus*, n. var. Pl. 2, fig. 21.

Ovate; whorls convex, with obtuse, transverse ribs—seven on the body whorl; covered by elevated, sharp, distinct, revolving lines, which on the older whorls alternate with faint ones; canal nearly straight; outer lip thickened, crenulate within; callus of inner lip with three obtuse teeth.

Locality.—Red Bluff, Miss.

Murex simplex, Aldr., from Byram Station, Miss., has spinous ribs.

TURRICULA CINCTA, n. sp. Pl. 1, fig. 13.

? *Mitra gracilis*, H. C. Lea. *Am. Jour. Sci.*, XL., 1841, p. 101, pl. 1, fig. 20.

Slender, except near the apex, where the whorls are rapidly diminishing in size; whorls eight, rather flat; except the first two, smooth, embryonic whorls, covered with transverse ribs, which become obsolete on the last whorls; parallel to the suture, an impressed spiral line produces a broad band along the suture; aperture narrow; columella with four folds, downward diminishing in size and extending over the base of the shell, striating it; outer lip sharp, spirally striated within at some distance from the margin.

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* *Mém de la Soc. Géol.*, 3me ser., III., 1884, p. 105, pl. 3, fig. 8.

Locality.—Claiborne, Ala.

It is impossible for me to decide whether the fragment of a young shell, which H. C. Lea described as *Mitra gracilis*, belongs to this species or not.

CONUS PROTRACTUS, Meyer. Pl. 2, fig. 7. *Am. Jour. Sci.*, XXIX., 1885, p. 466.

Spire nearly a third of the entire length; four smooth, rounded, embryonic whorls are followed by seven carinated volutions; the carina is somewhat crenulated; base with numerous broad, depressed lines.

Localities.—Vicksburg, Miss., Red Bluff, Miss.

Young specimens of *Conus sauridens*, Con., resemble the species, but their spires are concave and covered with revolving lines, which are absent in *C. protractus*.

PLEUROTOMA TEREBRIFORMIS, n. sp. Pl. 2, fig. 8.

Spire high; aperture and canal small, only about a quarter of the entire length; apex blunt, formed by two and a half smooth, embryonic whorls; adult whorls seven or eight—they are flat, have a revolving line above and below and a carina-like, noduliferous double line in the middle; on the older whorls more spirals appear in the interstices; the striæ of growth indicate a flat sinus, situated on the line in the middle; suture distinct.

Localities.—Claiborne, Ala., rare; Newton, Miss., Wheelock, Texas.

The type-specimen is from Claiborne.

PLEUROTOMA JACKSONENSIS, n. sp. Pl. 2, fig. 10.

Spire elevated, rather suddenly decreasing near the blunt apex; aperture and canal about one-third of the entire length; whorls covered with elevated, revolving lines and transverse ribs; a distinctly marked depression on the upper part of each whorl indicates the position of the rather deep sinus; columella thickened; outer lip crenate within.

Locality.—Jackson, Miss., rare.

PLEUROTOMA INFANS, n. sp. Pl. 2, fig. 9.

? *Fusus nanus*, Lea. *Contrib. to Geol.*, p. 150, pl. 5, fig. 155.

? *Pleurotoma insignifica*, Heilpr. *Proc. Ac. Nat. Sci.*, Philadelphia, 1879, p. 213, pl. 13, fig. 9.

Small; aperture and canal about one-third of the entire length; the pointed apex is formed by two and a half small, smooth, embryonic whorls; three rather large, transversely ribbed, embryonic whorls complete the nucleus; the largest specimen has three adult whorls—they are strongly carinated in the middle; the upper part has only one revolving line near the suture, the lower part three elevated spirals; the upper part indicates the position of the large, regularly rounded sinus; the lines of growth are almost rib-like.

Localities.—Red Bluff, Miss., Newton, Miss., Claiborne? Ala., Vicksburg, Miss (var.).

The type-specimen is from Red Bluff, where the species is not rare; it is much larger than the others of this locality, which have only two adult whorls. The only specimen from Vicksburg, which I have, however, is of the same size, and has also three adult whorls; though otherwise agreeing with the Red Bluff form, it is so decidedly stouter that a varietal name may be properly applied to it—"var. *brevis*." As the same species occurs also in Newton, I have little doubt that it is identical with that Claiborne form which is described by Lea as *Fusus nanus*. If this is so, it is one of the most generally distributed forms of *Pleurotoma* of the Southern Tertiary.

MANGELIA MERIDIONALIS, n. sp. Pl. 1, fig. 14.

Fusiform, somewhat inflated; spire turriculated, acuminated; canal short; nucleus consisting of two rounded and two carinated smooth whorls; adult whorls five, convex, with transverse ribs, about thirteen on each whorl, and with elevated spiral lines; these spirals are small and close together on the uppermost part of each whorl, which is defined by the sinus; sinus broad, near the suture; a curved varix on the outer lip.

Localities.—Claiborne, Ala., Red Bluff, Miss.

From Claiborne I have only the figured type-specimen, without preserved nucleus.

BULLA BITRUNCATA, n. sp. Pl. 2, fig. 24.

Short and stout; spire hidden; columella anteriorly with a strong, oblique fold; surface covered with indistinct, elevated, rounded, revolving lines.

Locality.—Jackson, Miss.

CYLICHNA OVIFORMIS, n. sp. Pl. 2, fig. 32.

Length nearly double the breadth; umbilicate at the top and with an umbilicate fissure at the columella; smooth, except some faint impressed, revolving lines.

Localities.—Jackson, Miss., Red Bluff, Miss.

The type-specimen is from Jackson. The form in Red Bluff seems to be a little more flattened.

CYLICHNA JACKSONENSIS, n. sp. Pl. 2, fig. 25.

Length two and a half times the breadth; umbilicate at the top and with an umbilicate fissure at the columella; the faint impressed, revolving lines are more distinct near the base and the top.

Locality.—Jackson, Miss.

Considerably more slender than the preceding species. *Cylichna St.-Hilairii*, Lea, sp., from Claiborne, is flat, almost cylindrical, while *Cylichna Jacksonensis* is rounded. The same differences exist in regard to *Cylichna Kellogii*, Gabb, from Texas.

CYLICHNA SUBRADIUS, n. sp. Pl. 1, fig. 17.

Cylichna confr. radius, Desh. *Am. Jour. Sci.*, XXIX., 1885, p. 468.

Small, rounded cylindrical; spire produced, acute; inferior part, except the base, with impressed, revolving lines; base with a minute, umbilicate fissure; aperture but little widening.

Locality.—Claiborne, Ala.

Belongs to the subgenus *Volvula.* In its slender and not inflated form and its acute top, it differs essentially from *Cylichna Dekayi*, Lea, sp., from the same locality. A similar species, however, seems to be ***Bulla cylindrus***, H. C. Lea,* from the Miocene. It scarcely differs from ***Bulla radius***, Desh.,† of the Paris basin. A specimen from Wheelock, Texas, determined as *Volvula Conradiana*, Gabb,‡ is less slender, but else very similar. An examination of a large amount of material may lead to a unison of *Cylichna subradius* with one or all of the last-named species.

ACTÆON ANNECTENS, Meyer. Pl. 2, fig. 30.

Am. Jour. Sci., XXIX., 1885, p. 466.

Conic-ovate; whorls six; one and one-half smooth, embryonic whorls form a blunt apex; adult whorls nearly flat, covered with elevated, flat, smooth spiral lines, separated by interstices of about equal breadth. These interstices are set with rather distant, elevated, transverse riblets, which, under the glass, give to the shell an almost cancellated appearance. Inner lip with a very strong and broad fold: in the oldest specimens, with a smaller one above it.

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* *Trans. Am. Philos. Soc.*, 1843, IX., Second Series, p. 250, pl. 35, fig. 43.

† Desh., An. s. vertèb., II., p. 226, pl. 39, figs. 22, 23.

‡ *Jour. Ac. Nat. Sci.*, Philadelphia, IV., Second Series, 1860, p. 386, pl. 67, fig. 51.

Localities.—Jackson, Miss., Red Bluff, Miss.

The figured specimen from Jackson is much larger than the others; and from Red Bluff I have only the smaller form, represented by more than a dozen specimens. Resembles *Actæon punctatus*, Lea., from Claiborne, but is much smaller, has a stronger fold, besides an additional one. The interstices between the revolving lines are larger, and the small ribs in them more distant and distinct.

ACTÆON INFLATIOR, n. sp. Pl. 2, fig. 31.

Globose, apex blunt; whorls six, covered with revolving impressed punctate lines; columella with one fold.

Locality.—Claiborne, Ala.

The longitudinal lines are continuous along the volutions; on the body whorl of the type-specimen, however, another system of these lines begins to appear between them. The single fold, together with the globose, regularly rounded form, distinguish this species from the other Actæon of the Southern Tertiary.

PTEROPODA.

STYLIOLA SIMPLEX, n. sp. Pl. 3, fig. 10.

Shell subulate, nearly straight, smooth; section circular.

Locality.—Jackson, Miss.

The closed end of this species is not inflated.

STYLIOLA HASTATA, n. sp. Pl. 3, fig. 11.

Shell subulate, nearly straight; section circular; closed end inflated.

Localities.—Vicksburg, Miss. (Higher and Lower Vicksburgian). Red Bluff, Miss.

Seems to be of smaller size than the preceding species. The type-specimen is from the Lower Vicksburgian.

Bovicornu, n. gen.

Shell minute, subulate pointed, spirally contorted.

Bovicornu eocenense, n. sp. Pl. 3, fig. 2.

Smooth, somewhat inflated at the closed end ; section circular.
Locality.—Red Bluff, Miss.

LAMELLIBRANCHIATA.

Arca inornata, n. sp. Pl. 1, fig. 24.

Trapezoidal ; anterior side truncated, flat ; beak small ; ligament area very low ; teeth smallest toward the middle ; covered with indistinct concentric lines ; margin entire.
Locality.—Claiborne, Ala.

Resembles *Arca lævigata*, Caillat,* from the Paris basin, but is less oblong.

Trigonocœlia ledoides, n. sp. Pl. 1, fig. 20.

Convex, ovate ; posterior side carinated ; hinge narrow, divided by a minute pit ; about eight teeth on each side ; more vertical near the pit, more horizontal near the end ; surface with concentric lines of growth crossed by indistinct radiating lines, which are not perceptible on the umbo ; beak turned toward the carinated side ; the muscular impression of this side is oval and less distinct ; an elevated radiating line passes along its side ; margin entire.
Locality.—Claiborne, Ala.

I found only the figured specimen, and this seems to be somewhat worn.

Leda mater, Meyer. Pl. 3, fig. 20. *Am. Jour. Sci.*, XXIX., 1885, p. 460.

Elliptically transverse, convex ; produced and truncate behind ; strongly inequilateral ; covered with concentric ribs and posteriorly with three radiating ribs ; teeth diminishing in size toward the fosset ; channel interrupted by a callus ; margin entire.
Locality.—Jackson, Miss. Not rare.

The concentric ribs are quite regular on the umbonial part of the shell;

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* Desh. An. s. vertèb. I., p. 905, pl. 68, figs. 23–26.

on the ventral part, however, about half of them vanish rather suddenly posteriorly, and the rest of them increase in size, so that the posterior part is covered by fewer but larger ribs. Many of the specimens have one or two indistinct radiating furrows on the anterior part. In some, the concentric ribs become erased like on the anterior part (see *loc. cit*).

LEDA TRIANGULATA, n. sp. Pl. 3, fig. 14.

Triangular; ventral margin rounded; near equilateral; ventricose; hinge-plate long and broad; surface nearly smooth, with indistinct concentric lines; margin entire.

Locality.—Red Bluff, Miss.

I found only the figured specimen.

LIMOPSIS RADIATUS, Meyer. Pl. 3, figs. 17, 17a. *Am. Jour. Sci.*, XXIX., 1885, p. 459.

Rounded, quadrangular; solid; hinge teeth, diminishing in size near the pit; surface covered by alternating radiating ribs, crossed by equal closely set, elevated concentric lines; the points of crossing are thickened by nodules; margin crenulate within.

Locality.—Jackson, Miss. Common.

The similarity of this species with *Lymopsis obliquus*, Lea, sp., is pointed out in the above cited place.

ASTARTE PROTRACTA, n. sp. Pl. 3, figs. 18, 18a.

Elongated, subquadrangular; umbonial part strongly flattened; adductors prominent; surface covered with distant concentric ribs, becoming obsolete on the umbonial part; margin entire.

Locality.—Enterprise, Miss.

The single specimen was collected by me in the stratum, in Enterprise, mentioned *Am. Jour. Sci.*, XXX., 1885, p. 70, as upper bed.

ASTARTE TRIANGULATA, n. sp. Pl. 3, figs. 21, 21a.

Trigonal, solid; pedal scar of anterior adductor distinct; lunule long and flat; surface closely covered with concentric ribs; margin crenulate.

Locality.—Red Bluff, Miss. Common.

The concentric ribs vary in size, in different specimens, and in some become obsolete toward the ventral margin.

MICROMERIS SENEX, n. sp. Pl. 3, fig. 22.

Small, solid; anterior margin straight, posterior margin curved; surface, except the umbo, covered with coarse radiating ribs.

Locality.—Claiborne, Ala. Stratum "g".*

LUCINA (CYCLAS) SUBRIGAULTIANA, n. sp. Pl. 3, fig. 13, 13a.

Orbicular, very regularly rounded; hinge teeth, two; laterals small; margin entire; surface covered with regular concentric waving lines, crossed occasionally by orbicular lines of growth.

Locality.—Vicksburg, Miss. Lower Vicksburgian.

Resembles very much *Lucina rigaultiana*, Desh.† A deep but extremely small lunule is in front of the beak. The lines of ornamentation are less distinct at their convex summit, thus creating a somewhat erased zone, which radiates from the umbo toward the posterior side of the ventral margin. The ornamentation looks as if produced by "*petits plans glissant les uns au dessous des autres.*"

LUCINA CHOCTAVENSIS, n. sp. Pl. 1, fig. 28.

Small, suborbicular; convex; lunule semilunar, well defined; cardinal and lateral teeth; anterior muscular impression relatively small; covered with concentric lines of growth.

Locality.—Vicksburg, Miss.

Lucina papyracea, Lea, from Claiborne, is similar, but the lateral teeth are obsolete.

LUCINA SMITHII, n. sp. Pl. 1, fig, 23.

Solid; irregularly elliptical; subequilateral; with cardinal and lateral teeth; a small but deep lunule inside of a larger indistinct one; surface with irregular lines of growth, becoming more regular at the extremities; they are crossed by very indistinct radiating lines; margin crenulate.

Locality.—Claiborne, Ala.

Named in honor of Dr. E. A. Smith, Tuscaloosa, Ala.

LUCINA BISCULPTA, n. sp. Pl. 1, figs. 30, 30a.

Thin; convex; oval; anterior margin truncated; beak turned anteriorly; lunule rather small; impressed; cordate; hinge of the right valve with one cardinal and two obsolete distant lateral teeth; inner surface with radiating impressed lines, which crenulate the margin; outer surface with concentric elevated distinct lines; except on the umbo they are separated by rather large and regular distances.

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* *Am. Jour. Sci.*, XXX., 1885., p. 69.

† Desh. An. s. vertèb. I., p. 631, pl. 47, figs. 28–30.

Locality.—Claiborne, Ala.

The radiating lines of the inside correspond, at some places near the margin, with indistinct rib-like elevations of the surface. By a mistake, the figure of this species, on plate 1, shows two teeth below the beak instead of one.

MACTRA INÆQUILATERALIS, n. sp. Pl. 1, fig. 18.

Substance of the shell thick; inæquilateral; triangular; anteriorly rounded; posterior slope carinated; covered with indistinct concentric lines, which are distinct on the extremities.

Locality.—Vicksburg, Miss.

As Conrad describes and figures *Mactra funerata** as equilateral, I am unable to refer the figured specimen to his species.

HINDSIELLA FABA, n. sp. Pl. 1, fig. 25.

Small, convex; sinus of the ventral margin gently rounded; covered with irregular lines of growth; muscular impressions ovately elongated; an indistinct oblique tooth below the beak (right valve).

Locality.—Claiborne, Ala.

Allied to *Hindsiella arcuata*, Lam., sp.† of the Paris basin.

ERYCINA WHITFIELDI, n. sp. Pl. 1, fig. 29.

Small; substance of the shell thin, porcellaneously shining; oval; convex; inæquilateral, the anterior side the largest; left valve with two obsolete pyramidal teeth on the anterior side, and on the posterior side a compressed one, which is very small and distant from the beak; surface shining, smooth, except very fine concentric lines of growth; margin entire.

Locality.—Claiborne, Ala.

The nearest species in the Paris basin seems to be *Erycina obsoleta*, Desh.‡ Named after Prof. R. P. Whitfield, whose descriptions and figures of American Eocene shells belong to the most careful ones.

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* *Jour. Ac. Nat. Sci.*, I., 2d Series, 1848, p. 121, pl. 12, fig. 13.

† Desh., An. s. vertèb., I., p. 695, pl. 53, figs. 32–35.

‡ Desh., An. s. vertèb., I., p. 720, pl. 53, figs. 16–19.

Kelliella? Bœttgeri, n. sp. Pl. 3, figs. 15, 15a.

Very small, orbicular, tumid, inæquilateral, umbo turned anteriorly; a cordate lunule is defined by an impressed line; surface closely and regularly covered with concentric ribs; hinge of the right valve with two diverging cardinal teeth below the umbo, and a horizontal one which is lamelliform before and beneath them; left valve with a short, oblique tooth below the umbo, and anteriorly with a horizontal S-shaped one; anterior adductor long; margin entire.

Locality.—Jackson, Miss.; common.

The pallial line is apparently simple. The shell in its dentition resembles somewhat the genus *Lutetia*, Desh., of the Paris basin, but on comparison with two species of this genus which I have, proves to be different. The genus *Kelliella*, Sars., as far as I am aware, is not a known fossil. I have no specimens of *Kelliella*, but according to its description and figure, I am inclined to put this small, remarkable Jackson shell into this genus.

Modiolaria Alabamensis, n. sp. Pl. 3, fig. 19.

Rhomboidal, thin; the small anterior and the large posterior part with radiating ribs, leaving the middle of the shell and the umbo smooth; hinge edentulous, anterior hinge-line notched.

Locality.—Claiborne, Ala.; "Lowest Claibornian."

The figured type-specimen is a young shell.

Corbula Aldrichi, Meyer. Pl. 1, fig. 21. *Am. Jour. Sci.*, XXX., 1885, p. 67.

Rounded trigonal; ventricose; posterior side carinated; beak small, curved anteriorly, in the left valve nearly in the middle; right valve briefly rostrated; in both valves the umbonial part is without concentric ribs, but with impressed, radiating lines—the ventral part with concentric ribs.

Locality.—Wood's Bluff, Ala.

The radiating lines cut only the first ribs and disappear completely at the ventral part. The species is similar to *Corbula gibbosa*, Lea., but distinguished mainly by the smooth umbonial part and the radiating lines.

Corbula Pearlensis, n. sp. Pl. 3, figs. 16, 16a.

Rather small, rounded, inflated; margin rounded anteriorly, truncated posteriorly; beaks very small, turned anteriorly; surface of both valves smooth on the umbonial part, covered with rounded concentric ribs on the ventral part.

Locality.—Jackson, Miss., rare.

VENERICARDIA INFLATIOR, Meyer. Pl. 1, fig. 26. *Am. Jour. Sci.*, XXIX., 1885, p. 460.

Small; cordate; ventricose; subæquilateral; margin subcircular; beak elevated and large, turned anteriorly; surface covered with about twenty ribs; they are smooth at the umbo, slightly crenulated toward the ventral margin; the interstices are about of the same size as the ribs; margin crenulated.

Locality.—Claiborne, Ala.

Differs from *Venericardia parva, Lea.*, from the same locality, principally in being smaller, more ventricose and rounded, and having a much larger beak.

VENUS RETISCULPTA, n. sp. Pl. 1, figs. 27, 27a.

Rhombically circular; convex; covered with broad, flat, and somewhat irregular concentric lines, crossed by similar radiating ones; the sculpture indistinct near the umbo; an impressed line separates a long lunule; pallial sinus large; margin entire.

Locality.—Claiborne, Ala.

The sculpture makes the surface appear as if reticulated with small rounded holes, especially in worn shells; the figured specimen shows the complete hinge, otherwise it is not the largest or best sculptured one.

ALVEINUS MINUTUS, Conrad. Pl. 1, fig. 19.

Alveinus parva, Con., *Am. Jour. Conch.*, 1865, p. 10.—List name.

Alveinus minuta, Con., *Am. Jour. Conch.*, 1865, p. 138. Pl. 10, fig. 2.

Alveinus parvus, Con., *Check List of Tertiary invertebr.*, 1866, p. 24.

Alveinus minutus, Con., *Proc. Acad. Nat. Sci.*, Phila., 1872, p. 53. Pl. 1, fig. 6.

Alveinus minutus, Con., *Am. Jour. Sci.*, XXIX., 1885, p. 467.

Small, nearly circular; inæquilateral; surface with concentric lines of growth, otherwise smooth and somewhat shining; beaks small, turned anteriorly; hinge divided by a minute trigonal pit; right valve with a pyramidal tooth on the anterior side; left valve with two compressed ones; muscular impressions subquadrangular, of about equal size; margin microscopically channeled within; pallial line simple.

Conrad described this species with the name of locality, "Enterprise, Miss." The specimen figured on plate 1 is from Claiborne, Ala., where the species is not rare. It is common in Jackson, Miss., and altogether occurs in so many other localities, that it may be considered as characteristic for the Southwestern Tertiary.

Periploma complicata, n. sp. Pl. 1, fig. 22.

The only specimen found is of the same fragmentary shape as that in which *Periploma Clairbornensis*, Lea., sp., a species not rare, constantly occurs. The fissure of the beak and the pearly nacre of the inside are well seen; the hinge with the spoon-shaped process is much more complicated than in *P. Claibornensis*, as the figure shows, the process consisting mainly of two concentric spoons.

Locality.—Claiborne, Ala.

ECHINODERMATA.

Echinocyamus Huxleyanus, n. sp. Pl. 3, fig. 23.

The only specimen found is fragile and damaged; it is egg-shaped, depressed, with rather coarse tubercles, large mouth and vent, the latter near the margin; a similar species is *Echinocyamus oviformis*, Forbes.*

Locality.—Claiborne, Ala.

FORAMINIFERA.

Nodosaria obliqua, L. sp. Pl. 1, fig. 31.

Of this widespread species I give a figure, as it is the only specimen of Foraminifera found as yet in the Claiborne Sand. The species occurs in most of the many localities of the Southwestern Tertiary.

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* *Pub. Pal. Soc.*, London.

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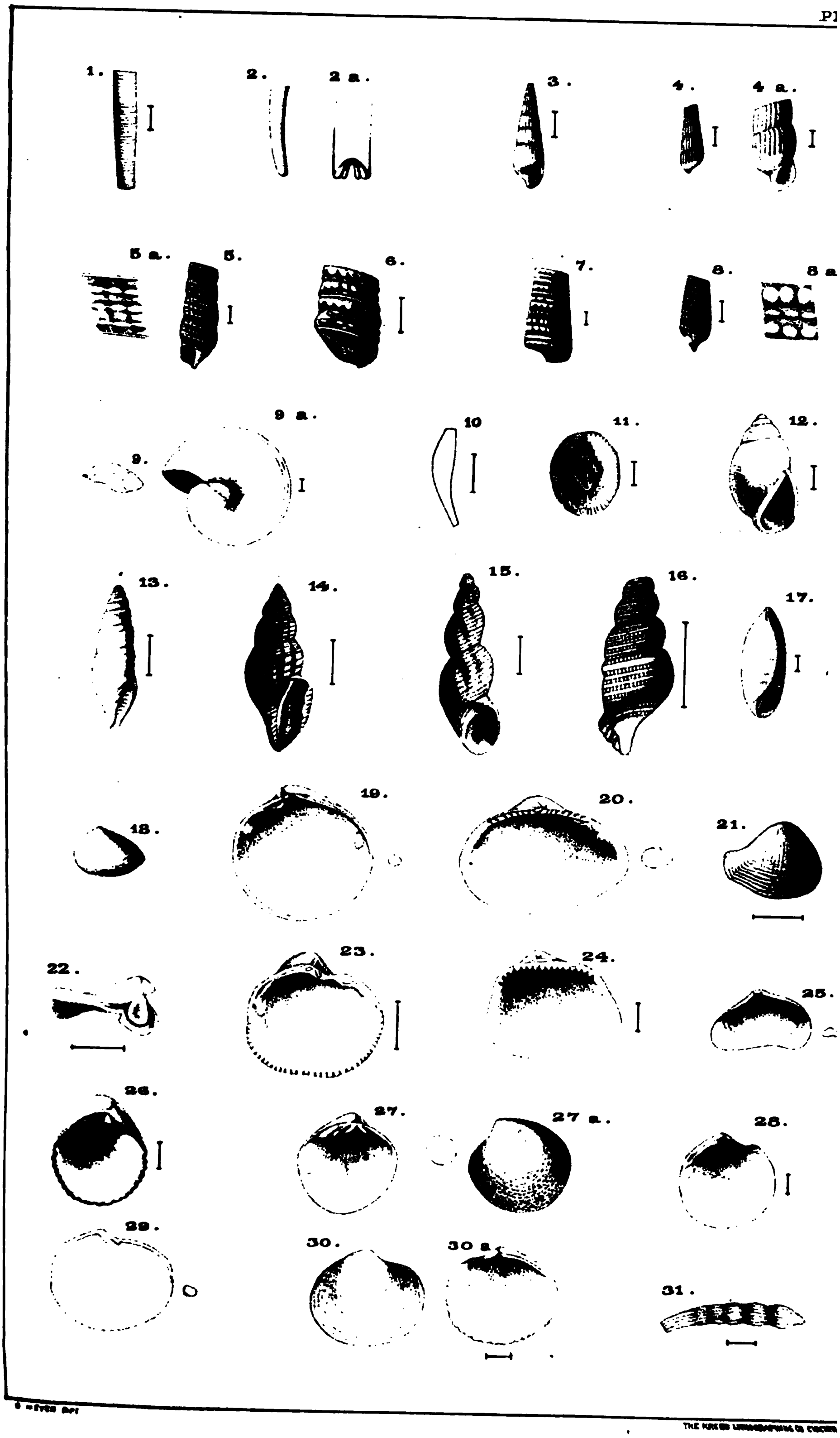

G. MEYER DEL.

THE KREBS LITHOGRAPHING CO. CINCIN

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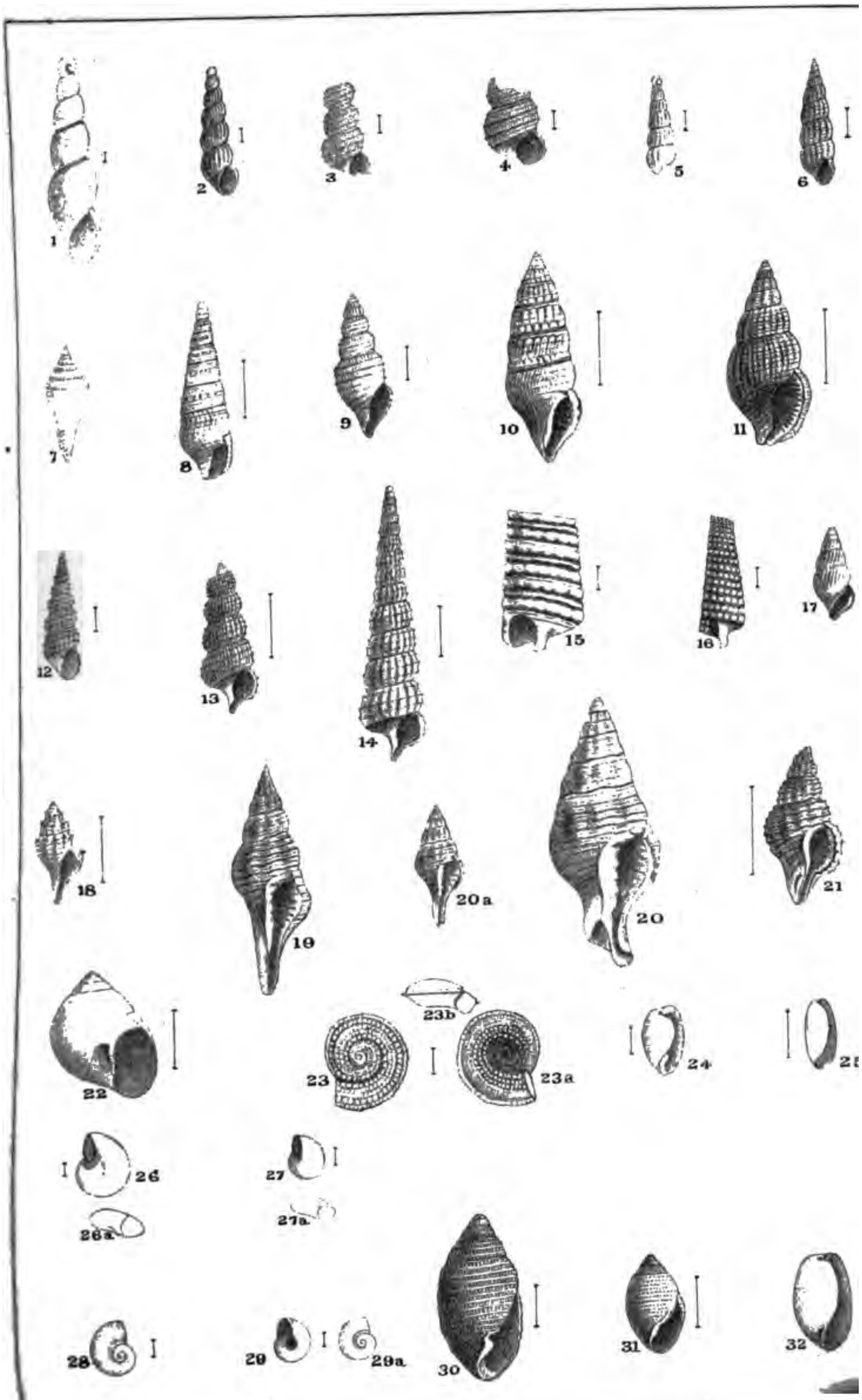

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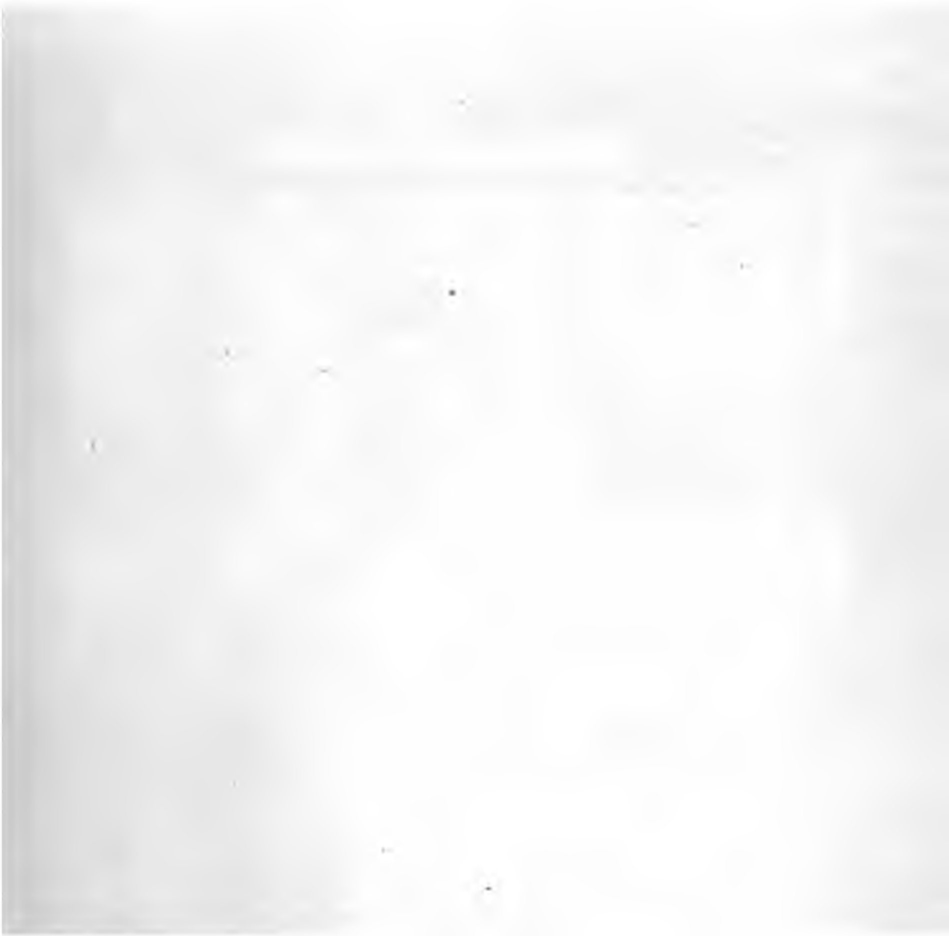

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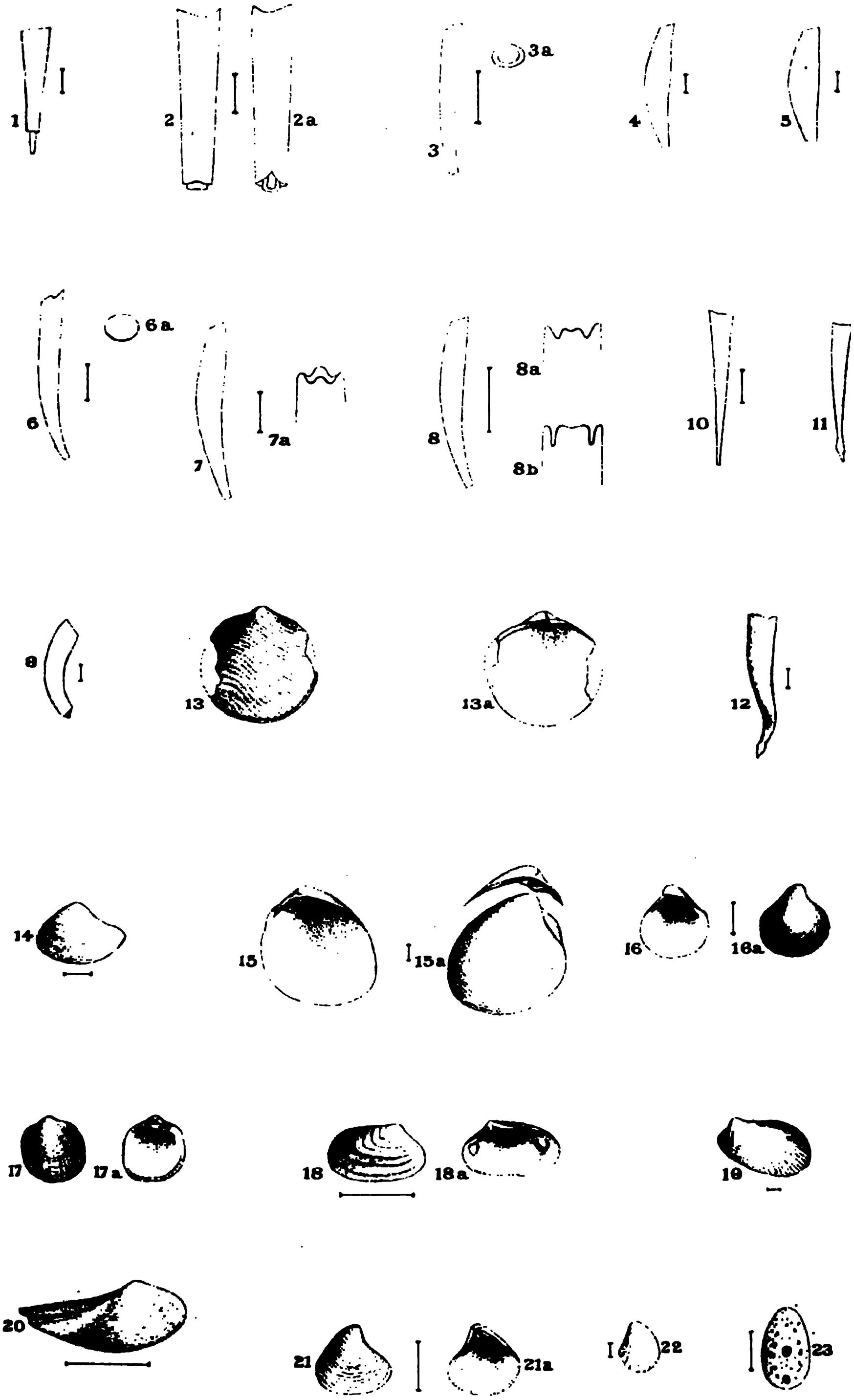

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GEOLOGICAL SURVEY

OF

ALABAMA.

BULLETIN NO. 2

ON THE

PHOSPHATES AND MARLS

OF

ALABAMA.

BY

EUGENE ALLEN SMITH,

STATE GEOLOGIST.

MONTGOMERY, ALA.:
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1892.

University of Alabama,
April 13, 1892.

To His Excellency,
Thos. G. Jones,
Governor of Alabama:

Dear Sir:—I have the honor to transmit herewith Bulletin No. 2 of the Geological Survey, on the Phosphates and Marls of Alabama.

Very respecfully,
EUGENE A. SMITH,
State Geologist.

PREFACE.

In the summer of 1883 the systematic examination of the Cretaceous and Tertiary formations of Alabama was taken up by the Geological Survey.

The first work was done in the vicinity of the Alabama and Tombigbee rivers by Mr. L. C. Johnson and myself, and later by Mr. D. W. Langdon and myself. The results of this study was a preliminary report on this region published as Bulletin No. 43, of the United States Geological Survey.

Since 1887 the examination has been carried eastward to the Chattahoochee river chiefly by Mr. Langdon, and a report upon the Cretaceous and Tertiary formations of the whole State is now in great part in manuscript and will be published as soon as the map, which is to illustrate it, can be made ready.

Enquiries are continually being made concerning the natural fertilizers of the State, and in view of the interest in these matters thus shown, it has been thought desirable to publish so much of the report above referred to as relates to the phosphates and marls of Alabama as a Bulletin in advance of the rest.

EUGENE A. SMITH.

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THE PHOSPHATES OF ALABAMA.

HISTORICAL.

In the early part of the spring of 1884 I received from Mr. J. W. Spencer, of Hamburg, Perry county, a box of phosphatic nodules and shell casts. Mr. Spencer's attention had been directed to these things which occurred on his land, by some published description of the South Carolina phosphates. He had sent specimens to Dr. C. U. Shepard, of Charleston, S. C., who had analyzed them, and, on recognizing them as phosphates, had sent his assistant, Dr. Chazal, to Alabama to investigate the occurrence. Dr. Chazal examined the ground and came to the conclusion that the phosphates were not in sufficient quantity to be of commercial value, and this conclusion seems to be borne out by our subsequent investigations, so far as the *high grade* phosphates are concerned, and these were all that Dr. Chazal particularly examined.

In April 1884, I went to Hamburg personally to see the mode of occurrence of the phosphates, and finding in addition to the nodular phosphates, a phosphatic greensand, and being satisfied that the latter at least, would become an article of great value to our agricultural interests, I announced the fact through the papers, and sent Mr. D. W. Langdon, Jr. Assistant in the State Geological Survey, to examine the occurrences about Hamburg more closely, and to follow the outcrop of these deposits from Hamburg east and west across the state.

Soon after my announcement, Prof. Stubbs of Auburn, and his Assistant, Prof. Leroy Broun, Jr., came also to Hamburg and the last named gentleman was with Mr. Langdon in his subsequent investigations about Hamburg.

Afterwards, Mr. Broun went into Macon, Russell, and Barbour counties, where he also found the phosphates.

state, it is probable that our experience would not be different from that of the people of South Carolina; our soils would as a rule be no better for it, since the greater part would undoubtedly be exported to enrich the soils of some other country.

On the whole it seems to me to be a matter for congratulation rather than otherwise that the most abundant phosphates of Alabama are of a nature which will probably keep them at home. If they are used rationally by our people, there can be no doubt that the enhancement in the value of lands and the increase in the crops due to their use, will represent a larger amount of capital than would the trade in exported rock. And even if the sums realized by exportation were greater the money would be in fewer hands, and therefore accomplish less general good.

It is discouraging that our people as a rule are so slow in taking advantage of the natural fertilizers of the state.

This is however, in great measure due to lack of information on the subject; and as comparatively little printed matter comes under the notice of the majority of our farmers they can never be induced by any amount of writing to take up these things which lie at their very door.

It is only by the example of the best posted, and most successful farmers of each neighborhood, who are willing to experiment with these fertilizers, and show practically their value, that the great mass of the farmers will ever be brought to use them. Fortunately, in several parts of the state, there are farmers who have made practical field tests of these marls, and from these as a center, the infection will spread it is to be hoped, over the whole state.

GEOLOGICAL AGE, MODE OF OCCURRENCE, AND COMPOSITION OF THE PHOSPHATES.

Phosphatic marls have been found in Alabama both in the Cretaceous and Tertiary formations, and for our present purposes they can be most conveniently considered in their geological relations.

From the margin of the area occupied by the rocks of the older formations of this state, the strata of the Cretaceous and Tertiary formations, make up the whole mass of the land southward to the gulf of Mexico. The margin of these older rocks, which is at the same time the inner or upper margin of the lowest of the Cretaceous formations, stretches in a curve from the north-western corner of the state across near Fayette Court House, Tuscaloosa, Centerville, and Wetumpka, to Columbus, Georgia. All the Cretaceous and Tertiary beds have a gentle slope or dip towards the gulf of 25 to 40 feet to the mile, and they occupy the surface across the state in approximately parallel belts, the oldest beds furthest north, and the newer further towards the south in the order of their relative ages. As a further consequence of this dip of the strata, each one of these beds, while appearing at the surface only in a comparatively narrow belt, passes beneath the newer beds, and may be found below the surface at depths constantly increasing as we go southward.

The geographical distribution of the surface outcrops of the several divisions of the Cretaceous and Tertiary may be seen by reference to the map accompanying my Agricultural Report for the years 1881-2. But since that report will probably be acessible to very few, I shall preface the detailed descriptions of the marls, by a short account of each of the formations in which they occur:

CRETACEOUS FORMATION.

General Characters.

This formation is made up of some 2600 to 3500 feet in thickness of strata, which are sands, clays, and limestones in many alternations. The subdivisions of the formation are four in number, which in ascending order are as follows:

1. THE TUSCALOOSA.—This, the lowermost of the Cretaceous series, consists in the main of sands and clays aggregating,

Alabama, where the Rotten Limestone seems to be entirely wanting.

Phosphatic Deposits of the Cretaceous.

As before stated, the phosphatic deposits of our Cretaceous formations occur mainly in two positions, viz: At the base and at the summit of the Rotten Limestone; in both cases in transition beds between this and the underlying and overlying rocks. The Rotten Limestone being, as above noted, a calcareous clayey formation in great part, yields upon disintegration soils that are for the most part strongly limy, and colored dark and sometimes nearly black with vegetable matter. The region formed by the Rotten Limestone is commonly known throughout this state under the names "Black Belt," "Canebrake," "Black prairies," in allusion to prominent characteristics. The positions of the two areas in which the most important of the phosphatic deposits are to be looked for are easily located; the one occurs along the northern border of the prairie belt, and the other along its southern border, in both cases where the transition from the lime lands to the sandy lands is found. The phosphate belt to the north of the prairies we have named the *Eutaw, Hamburg, Selma Belt;* the one to the south of the prairies is known as *Livingston, Fort Deposit, Union Springs Belt.* In the special descriptions of these occurrences it will be best to consider them separately.

1. THE EUTAW, HAMBURG, SELMA BELT.

HAMBURG.

Mr. J. W. Spencer appears to have been the first to suspect the true character of the phosphatic nodules which are so abundant about the old town of Hamburg in Perry county. After analyses made by Dr. C. U. Shepard, of Charleston, S. C., and in the laboratory of the Alabama Geological Survey at Tuscaloosa, had placed beyond doubt the composition of these nodules, the locality was visited and closely examined by a number of persons, but particularly by Mr. D. W. Langdon, Jr., of the Geological Survey, and Mr. W. Leroy Broun, Jr., Assistant Chemist of the A. & M. College.

The following section of the strata at Hamburg, given in descending order, will show the mode of occurrence and general character of the phosphatic materials at that place:

Section at Hamburg.

1. Base of the Rotten Limestone. The beds here included contain very little phosphoric acid.

2. Greensand, averaging about five feet in thickness, and strongly impregnated with phosphoric acid. The lowermost strata of this greensand contain a few phosphatic nodules, which, however, become much more abundant in the next succeeding stratum.

3. Sandy calcareous stratum, matrix of the nodules, five to six feet in thickness. Where this bed outcrops in the fields the surface of the ground is covered with the phosphatic nodules, which are concretionary masses of nearly pure phosphate of lime, of exceedingly irregular shapes, and from sizes varying from small pebbles no larger than a pea to pieces two or more inches in diameter. The nodules vary also in color, from light gray to dark brown, and they may easily be recognized by the peculiar odor which they emit when rubbed together or broken. This odor is described by some as "fishy," by others as "bituminous" or "naphthous," as it resembles to some degree the odor of crude petroleum. Along with these phosphatic nodules are also great numbers of casts or moulds of fossils, usually somewhat worn, and badly preserved, and consisting of fragments of ammonites, baculites, nautili, and other well known Cretaceous forms. These casts have themselves, in most cases, been more or less phosphatized, and in some instances have almost entirely lost their original shape and structure, and are then difficult to distinguish from the nodules. Besides these there are great numbers of the teeth of sharks and bones of saurians.

The nodules are found as above stated, in small numbers in the lower beds of the greensand, but more abundantly in

Analyses of Phosphatic Nodules and Shell Casts, Spencer's Field, Hamburg.

	Insol'ble Matter.	Phosphoric Acid.	Bone Phosphate.	Lime.	ANALYST.
1. Surface Nodules (selected)	......	38.00	82.84	....	John Daniel, Univ'ty of Ala.
2. " "	....	35.5	77.39	....	" " "
3. Surface nodules, sample of 1 lb	....	25.66	55.88	......	Chas. Gibson, Chicago.
4. Nodule	......	22.02	48.00	....	W. I. Herzberg, Univ. of Ala.
5. Phosphatized shell	......	19.80	43.16	....	" " "
6. Surface nodules	1.09	26.13	57.04	....	Laboratory A. & M. College.
7. Black nodules	2.50	24.16	52.03	....	" " "
8. White nodules	21.94	20.07	43 81	....	" " "
9. Mixed nodules	9.79	19.97	43.59	....	" " "
10. Nodules from Pit No. 1	22.07	14 02	30.60	39.03	" " "

b. Matrix of the Nodules, Spencer's Field, Hamburg.—It may be seen from the section (page 17) that the nodules are imbedded in a stratum some five or six feet thick. The material of this matrix is sandy and calcareous, and it is strongly phosphatic, as may be seen from the analyses following, (page 23). It would undoubtedly be a good fertilizer:

Analyses of the Matrix of the Nodules, Spencer's Field, Hamburg.

	Insol'ble Matter.	Phosphoric Acid.	Bone Phosphate.	Lime.	ANALYST.
11. Matrix of nodules	......	4.2	9.16	....	John Daniel, Univ'ty of Ala.
12. Blue matrix of nodules	....	2.2	4.80	....	Chas. Gibson, Chicago, Ill.
13. White matrix of nodules	....	3.6	7.85	....	" "
14. Matrix rock, from Pit No. 1	30.28	2.58	5.63	30.06	Laboratory A. & M. College
15. " " 3	32.50	3.85	8.40	29.61	" " "
16. " " 1	40.61	2.45	5.34	27.07	" " "
17. Matrix rock, 6 feet below surface, Pit No. 3	53.74	2.79	6.09	17.20	" " "
18. " 5 feet 9 in. below surface, Pit No. 1	33.81	2.26	4.93	27.85	" " "
19. " 29 in. below surface, " 2	47.13	1.46	3.18	24.41	" " "
20. " 9½ in. below surface, " 2	27.82	.95	2.09	41.00	" " "
21. " 21 in. below surface, " 2	31.55	3.58	7.81	32.07	" " "
22. Rock overlying matrix rock	35.17	2.20	4.80	24.10	" " "

c. *The Greensand, Spencer's Field, Hamburg.*—This bed is some five feet in thickness, and is throughout rather strongly impregnated with phosphoric acid. In some parts of the field, where exposed, this substance is indurated into a pretty firm rock, but in other places it is friable and incoherent, and occasionally it forms the suface soil which is cultivated. The analyses show a considerable variation in the percentage of phosphoric acid, the indurated rock containing the largest proportion, the loose rock next, and the soil least. Some of the analyses made from picked specimens of the hard greensand rock, show as much as 10 per cent phosphoric acid, but as the average is a good deal lower than this, I have inserted in the table (page 25) only such analyses as appear to represent the general average per cent of the phosphoric acid. The greensand taken from the pits dug by Mr. Langdon, show less phosphoric acid than the samples taken from the surface.

Analyses of Greensands—Spencer's Field, Hamburg, Perry County.

	Insol'ble Matter.	Phos-phoric Acid.	Bone Phos-phate.	Lime.	ANALYST.
23. Indurated, greensand	....	9.00	19.62	......	John Daniel, Univ'ty of Ala.
24. " "	....	5.16	11.26	....	C. R. Westcott, " "
25. " "	....	8.12	17.70	....	Eugene A. Smith " "
26. " "	......	7.60	16.59	....	Chas. Gibson, Chicago.
27. Greensand, first 12 in. Pit No. 1	42.66	1.61	3.51	16.18	Laboratory A. & M. College.
28. " 9 in. below 27 "	34.52	2.79	6.09	13.86	" " "
29. " 7 in. below 28 "	31.55	2.13	4.65	9.14	" " "
30. " 20 in. below 29 "	......	3.38	7.37	8.40	" " "
31. Greensand forming soil, cultivated	41.42	.67	1.46	29.62	" " "
32. " " " "	41.11	.85	1.85	17.68	" " "
33. " " " "	48.81	4.35	9.56	9.13	" " "
34. " " " "	28.62	.66	1.44	24.80	" " "
35. White nodules found in greensand	3.91	3.85	8.40	49.83	" " "
37. Indurated greensand	....	4.80	10.26	....	D. W. Langdon, Jr., U. of A.
38. " "	....	5.90	12.86	....	" "

In order to ascertain whether or not it would be possible to concentrate the phosphatic material or the greensand grains of this stratum, Mr. Langdon made some experiments with the indurated greensand, loosely pulverizing it, subjecting it to strong mechanical agitation, then separating the upper half from the lower, and analyzing each as to its content of phosphoric acid and potash. Another experiment was made by stirring the pulverized greensand in water, allowing to settle and then determining the phosphoric acid and potash of the upper and lower halves as before. In neither case was any very marked result obtained, but there seems to be good reason for thinking that by some such mechanical process, it will be possible to concentrate the phosphate so as to render it suitable for shipment.

d. Sands and other strata underlying the nodule bearing bed at Spencer's, near Hamburg.—Samples were taken of the materials underlying the nodule bed, at intervals of three feet, for some eighteen to twenty feet, and also of the indurated ledge between the nodule bed and the sands. All these contain phosphoric acid in considerably larger proportions than is commonly found in soils.

The subjoined analyses (page 27) show the phosphoric acid in the different parts of the Hamburg strata:

Analyses of the Strata Underlying the Nodule Bed—Spencer's, Hamburg.

	Insol'ble Matter.	Phos-phoric Acid.	Bone Phos-phate.	Lime.	ANALYST.		
39. First three feet below surface, Spencer's house	31.53	3.38	7.37	26.73	Laboratory A.	& M.	College.
40. Three feet below 39	56.65	.69	1.50	21.20	"	"	"
41. Indurated ledge	53.77	1.16	2.53	23.33	"	"	"
42. Two feet below ledge No. 41	92.30	.33	.72	9.47	"	"	"
43. Sands 3 feet below 42	91.89	.29	.63	2.85	"	"	"
44. Sands 3 feet below 43	95.55	.44	.96	.72	"	"	"
45. Sands 3 feet below 44	96.27	.12	.25	.75	"	"	"
46. Sands 3 feet below 45	92.14	.39	.85	.69	"	"	"
47. Feruginous sand below King's Mill	91.40	.43	.92	.79	"	"	"
48. Lowest formation at King's Mill	90.42	.25	.54	.50	"	"	"

No. 39 is evidently a part of the nodule-bearing stratum of which several analyses have been given in a preceding table (page 23).

NEAR CAHABA RIVER.

From Hamburg, Messrs. Langdon and Broun followed the phosphatic formation eastward to the Cahaba River, where the following geological section was observed by them:

Section near Cahaba River, on land of Messrs. A. F. and A. J. Davis:

1. Rotten Limestone, increasing in depth southward.
2. Greensand marl, 5 to 6 feet thick.
3. Soft cream-colored rock, phosphatic, and bearing some nodules, and passing below into a grayish limestone holding the nodules, 4 to 6 feet.
4. Indurated calcareous sandy ledge, 1 to 1½ feet.
5. Yellow micaceous sand, the upper part holding shells; 30 feet.
6. Dark red sand containing more greensand than No. 5, the red color due probably to oxidation of greensand, 15 feet.
7. Indurated ledge similar to No. 4, but more variable in thickness, 6–12 inches.
8. Whitish sand with few grains of greensand, 10 inches.
9. Blue joint clay varying from 8 inches to 4 feet in thickness.
10. Red or orange colored sands similar to No. 6, 10 feet.
11. Greensand, four feet exposed above the water level in Cahaba river.

WEST OF HAMBURG.

Westward from Hamburg, Mr. Langdon traced the greensand and accompanying nodule-bearing bed, by Marion, Newberne, Greensboro, Cocke's Mill, etc., to Eutaw, and from correspondents I have also received specimens from Pleasant Ridge and Pickensville. Subsequently, Judge Lawrence C. Johnson, of the U. S. Geological Survey, followed the line of outcrop of these beds far into Mississippi.

Between Hamburg and Cocke's Mill, six miles west of Greensboro, the greensand bed has substantially the same characters as at Hamburg, and the phosphatic nodules are also similar in quantity and quality to those already described. I have given below a number of analyses of the different kinds of phosphatic materials occurring along this line. There is no reason for thinking that the occurrence is not continuous between Hamburg and Cocke's Mill, or indeed to the Mississippi line. See analyses 49 to 60, (page 30).

On the Warrior river these deposits are again seen at Choctaw Bluff and at the old Erie landing. At both places the greensand is found immediately underlying the lowermost beds of the Rotten Limestone. At Erie, curious stalagmitic masses of indurated sand are formed in the loose sands which fall down the face of the bluff, the cementing principle being, as analysis shows, phosphate of lime. Analyses are found in the subjoined table Nos. 61 and 62, (page 30).

At Eutaw the greensand bed is well seen in the railroad cut near the depot. This greensand contains some imbedded phosphatic nodules, but the greater part of the nodules are to be found in a whitish sandy calcareous matrix, also seen in the railroad cut; at a well in the fair grounds; in a field east of town, belonging to Mr. Kirksey; and on the western edge of town at Mr. C. S. Bray's. In all these localities there are phosphatic shell casts, sharks' teeth, and the other fossils common to the phosphate beds elsewhere. Analyses of the materials occurring about Eutaw are seen in the table (page 30), Nos. 63, 64, 65, 66 and 67.

Specimens have also been received from Pleasant Ridge, from Mr. R. K. Horton, from the Turkey creek hills close to that town; and from Pickensville Mr. Walton Harrison has sent others. From both these localities, only nodules and phosphatic casts have come, but there seems to be no reason for thinking that the greensands are absent. For analyses see table (page 30) numbers 68 and 69.

Analyses of Specimens Occurring Westward from Hamburg.

	Insol'ble Matter.	Phosphoric Acid.	Bone Phosphate.	Lime.	ANALYST.
Marion and Vicinity.					
49. Phosphatic casts, A. T. Moore	7.91	27.74	60.55	....	Laboratory A. & M. College.
50. Indurated phosphate rock, M. W. Oliver	7.61	11.05	24.12	....	" " "
51. Light colored greensand, M. W. Oliver	....	2.98	6.50	....	" " "
52. Dark bluish greensand, M. W. Oliver	....	2.57	5.61	....	" " "
53. Phosphatic nodules, Judge Bailey	25.91	26.74	58.37	33.55	" " "
54. Greensand, Carlos Reese	37.70	3.78	8.25	....	" " "
55. Phosphatic casts, Dr. W. W. Wilkerson	12.55	14.23	31.06	....	" " "
Newberne and Greensboro and Vicinity.					
56. Greensand, E. N. Driver, Scotts Station	....	2.36	5.15	....	" " "
57. Nodules and phosphatic casts, Mrs. Jemison	10.85	23.10	50.43	....	" " "
58. Phosphatic casts, Chas. W. Turpin	7.73	26.54	57.94	....	" " "
59. Phosphatic casts, Dr. J. B. Reid, Greensboro	16.22	23.20	50.64	39.34	" " "
60. Greensand, Cocke's Mill	....	4.30	9.38	....	Chas. Gibson, Chicago.
Warrior River.					
61. Greensand, Choctaw Bluff	....	5.03	10.96	....	W. I. Herzberg, Univ. of Ala.
62. Stalagmitic formation, Erie	....	1.16	2.53	....	D. W. Langdon, Jr., "
Eutaw and Vicinity.					
63. Greensand, from railroad cut, Eutaw	....	.60	1.31	....	Laboratory A. & M. College.
64. Indurated greensand, Fair Grounds, Eutaw	39.87	3.24	7.07	....	" " "
65. Nodules and casts, Kirksey's field	9.44	21.53	47.00	41.72	" " "
66. Greensand marl, T. J. Anderson, Eutaw	....	1.53	3.35	....	Eug. A. Smith.
67. Phosphatic nodules, A. W. Anderson, Eutaw	26.99	16.48	35.97	34.57	Laboratory A. & M. College.
West of Eutaw.					
68. Nodules and phosphatic casts, Pleasant Ridge	5.90	25.14	54.88	....	" " "
69. Nodules and phosphatic casts, Pickensville	4.21	22.40	18.90	....	" " "

EAST OF HAMBURG.

Mr. John Daniel, of the University of Alabama, went for me to examine the country east of Hamburg, and found the phosphates between Selma and Summerfield, and within a few miles of the first named place. From here he went into Autauga county, following the line of the outcrop of the phosphates as far as Prattville. Meanwhile I had received from several gentlemen near Selma specimens from a number of localities which proved to be phosphatic, and in Autauga county Mr. Leonidas Howard and Dr. S. P. Smith made tolerably thorough examinations of the vicinities of Mulberry and Prattville, where the greensand beds were discovered. The analyses of these greensands show that they are valuable fertilizers.

Along with the greensands are the usual phosphatic nodules and shell casts, and near Prattville also Col. Doster's farm and Dr. A. S. McKeithen's place, a hard phosphatic limestone, which may some day be utilized. From the vicinity of Wetumpka also came specimens from Mr. John Enslen showing that the greensand deposits extended in that direction also. Prof. Broun of Auburn has traced the outcrop of the phosphatic deposits through Macon and Russel counties almost to the Georgia line, but found them so deeply covered with the sands of the drift that they will hardly be utilized.

We thus see that the phosphate outcrops across the state probably without a break in the continuity, and with very considerable uniformity in composition, and it is almost certain that valuable greensands are to be had merely for the cost of digging them up, for this whole distance.

The following tables (pages 32 and 33) show the composition of the materials which have been collected from the various localities east of Hamburg:

1. *Selma, Summerfield and Vicinity.*

	Insol'ble Matter.	Phos-phoric Acid.	Bone Phos-phate.	Lime.	ANALYST.
70. Nodules, from near Selma	......	26.1	56.90	......	John Daniel, Univer'ty of Ala.
71. " " "	....	25.8	56.24	....	" "
72. " " "	....	36 0	78.68	......	" "
73. " " "	....	38.0	82.84	......	" "
74. Matrix of nodules, from near Selma	....	5.05	10.11	....	" "
75. " " " "	......	3.98	8.67	....	" "
76. Greensand, three feet thick, J. R. Barker's Mill	......	3 60	7.85	9.70	Laboratory A & M. College.
77. Greensand, J. R. Barker's Mill	....	5.47	11.26	....	John Daniel.
78. Nodules, 3 m. S-E. of Summerfield, overlying greensand	2.67	25 59	55.85	......	A. & M. College Laboratory.
79. Greensand, near Selma, Jos. Hardie	....	5.22	11 39	......	" "
80. Nodules and casts, near Selma, J. H. Robbins	6.49	24 85	54 25	31.57	" "
81. Nodules and casts, near Selma, Keenan place	50.68	12 88	28.11	22.20	" "

2. *Autauga and Elmore Counties.*

Analyses 82 to 89 inclusive are from specimens collected in western Autauga by Mr. Leonidas Howard; 90 and 91 are from Day's Bend, sent by Mr. W. A. Gunter; 92 to 96 inclusive, from near Prattville, sent by Dr. S. P. Smith and John Daniel; and 97, 98 and 99, collected by Mr. John Enslen, of Wetumpka.

	Insol'ble Matter.	Phos-phoric Acid.	Bone Phos-phate.	Lime.	ANALYST.
82. Hard Siliceous limestone, near Mulberry	57.17	0.78	1.70	......	Laboratory A. & M. College.
83. " " " with shell casts, near Mulberry	49.05	4.86	10.61	26.55	" " "
84. Clayey limestone, with greensand upper part, "	....	2.20	4 80	7.99	" " "
85. Clayey limestone, with greensand lower part, "	....	1.69	3.69	14 89	" " "
86. Greensand 10 inches thick, Mulberry	....	2.49	5.43	8.38	" " "
87. Greensand marl from well, Mulberry	....	6.67	14.56	7.57	" " "
88. Main greensand bed 3 feet thick, Mulberry	.....	2 63	5 74	....	" " "
89. Phosphatic lime rock, Mulberry	1.97	2.10	4.52	....	" " "
90. White phosphatic marl, Day's Bend	43.79	4.10	8.95	....	" " "
91. Phosphatic casts and nodules, Day's Bend	19.52	20.77	45.34	....	" " "
92. Nodules, near Prattville	....	28.14	61.34	....	E. M. Harris, Univ'ty of Ala.
93. Nodules, near Prattville	......	32.0	66.76	......	" " "
94. Phosphatic shell rock, A. S. McKeithen, near Prattville.	52.72	11.24	24.49	....	D. W. Langdon " "
95. Matrix rock, Bear creek, " "	29 48	2.71	5.92	....	" " "
96. Greensand marl, " "	54.72	1.37	2.99	....	" " "
97. Greensand marl, near Wetumpka	66.15	1.52	3.31	4.33	Laboratory A. & M. College.
98. White phosphatic marl, near Wetumpka	41.36	1 11	2.42	32.11	" " "
99. Clayey phosphatic marl, near Wetumpka	34.68	1.96	4.28	....	D. W. Langdon, Univ. of Ala.

It has already been said above that Prof. Leroy Broun, Jr., of Auburn, was sent to examine the phosphatic deposits in the eastern part of the state. His report to Prof. Stubbs is given in full in Bulletin No. 5 of the Agricultural Commission, and from this report I take the following notes:

The phosphatic formation was first recognized by Mr. Broun on the place of Mr. T. L. Nobles, S 36, T 17, R 23, and it consists of a greensand underlying the superficial loams and clays. The same greensand was also found at several other localities, as at Mr. Frank Howard's, S 22, T 16 R 23, also a mile east of Mr. Howard's and on the Mr. J. M. Comer's place four miles southeast of Tuskegee. Thence eastward the greensand bed was traced to Smith's Store, to within one and a half miles south of Society Hill, and within one mile of Marvin. The analyses which are presented (page 35) of the specimens collected by Mr. Broun, show that the marl is not very strongly phosphatic, and being moreover deeply covered by the sands of a later formation, is not likely to become of much importance.

The measurements of Mr. Broun show that the greensand is quite thick, averaging perhaps over six feet.

3. *Macon and Russell Counties.—Specimens Collected by Prof. Leroy Broun, Jr.*

	Insol'ble Matter.	Phosphoric Acid.	Bone Phosphate.	ANALYST.
100. Greensand, T. L. Noble's, Macon county	80.90	.45	.98	Laboratory A. & M. College
101. " F. Howard's, near Tuskegee	74.90	.31	.67	" " "
102. " Charlie Cr——, Calebee swamp	66.71	.77	1.68	" " "
103. " from well near Tuskegee	75.67	.59	1.28	" " "
104. " shell marl, A. Smith's, near Uchee	74.46	.59	1.28	" " "
105. " J. M. Comer's, near Tuskegee, first 8 inches	71.35	1.29	2.81	" " "
106. " J. M. Comer's, near Tuskegee, average of five samples, taken at depths down to eight feet *	78.78	.50	1.09	" " "
107. Ferriginous sand, below Comer's greensand	82.25	.70	1.52	" " "
108. Phosphatic rock, J. P. Morris', Society Hill	10.77	5.34	11.65	" " "
109. Greenish loam, Chattahoochee river, mouth of Uchee creek	71.00	.96	2.09	" " "
110. Blue clay, mouth of Uchee creek, Chattahoochee river	77.26	.21	.45	" " "

*In these samples the percentage of phosphoric acid decreases regularly with the depth.

2. THE LIVINGSTON, FORT DEPOSIT, UNION SPRINGS BELT.

The rocks of this belt crop out across the state, along the southern border of the prairie region, just as those of the first named belt, appear as a border along the northern edge of the prairies.

The localities are, of course, very numerous, and as some of the rocks, especially the hard crystalline limestone, appear to contain uniformly a high percentage of phosphoric acid, the aggregate amount of this substance is very great.

The mode of occurence of the phosphoric acid in the rocks of this belt is somewhat similar to that above described, viz: It is found impregnating the siliceous limestone and white calcareous marls, as well as greensand marls, and is also seen in concretionary masses of nearly pure phosphate of lime, and in the moulds and casts of fossils, which are all strongly phosphatic, having nearly the same composition as the nodular phosphates themselves. It is interesting to note in this connection that wherever the original substance of the shell is present in any of these fossil remains, as is the case with the *exogyras and gryphœas*, of the oyster family, so abundant throughout the prairie region, there is scarcely a trace of phosphoric acid.

In the vicinity of the Tombigbee and Alabama Rivers the upper or Ripley group of the Cretaceous consists of the following well marked divisions:

First. Yellow sands about fifty feet, holding in many localities large beds of highly phosphatic shell casts.

Second. Dark gray micaceous sandy clays and clayey sands, about 100 feet thick, traversed by hard ledges of similar materials, and not very prolific of fossils. In these beds we find at many localities a bed of phosphatic greensand full of soft pulverized carbonate of lime. This greensand is some three feet or more in thickness, contains about 1.5 per cent. of phosphoric acid, and has been very successfully used as a fertilizer. This is probably the most important of the phosphatic materials occuring in this belt, and several analyses are given below, from which its composition may be seen.

Third. Thirty to thirty-five feet of a bluish argillaceous limestone, with great numbers of Cretaceous shells, which are, however, mostly in the form of casts, and strongly phosphatic. Along with these are irregularly shaped nodules of phosphate of lime, similar to those occuring in the Hamburg belt, and in most of the localities examined we find below this fossiliferous bed a stratum of siliceous limestone of very variable thickness, which also is strongly impregnated with phosphate of lime. It is quite possible also that some of the hard bands which traverse the sands next to be described are also phosphatic.

Fourth. Some sixty feet or more of sands of various colors, with indurated bands passing through them. As a rule, these sands are not very markedly fossiliferous, but the hard ledges usually hold great numbers of *exogyras* and *gryphœas.* As stated above, it seems probable that some of the siliceous phosphatic rocks, of which analyses are given (page 44), belong to this division of the Ripley. This seems all the more probable from the fact that the uppermost strata of the Rotten Limestone itself, which follow next below the sands in question, hold in some cases a very notable percentage of phosphoric acid. This is shown by the analyses of specimens collected from the vicinity of Livingston. These specimens were all taken from the surface, and appear to be in most cases only the crumbling or disintegrating portions of the Rotten Limestone, and yet when the compact rock immediately underlying these phosphatic fragments is examined, it usually shows a very small proportion of phosphoric acid. In all cases the shell casts were phosphatic. The specimens about Livingston were collected by the writer in company with Dr. R. D. Webb, whose knowledge of the geological and topographical features of Sumter county is extensive as well as accurate. Many years ago Dr. Webb made analyses of some of these very materials, and in the newspapers called attention to the comparatively large percentage of phosphoric acid which they contained.

It seems further probable that throughout the Rotten Limestone there are beds in which the proportion of phosphate of lime is very considerable, or in which at least the shell casts are strongly phosphatic. This is shown by the analyses given (page 44) of phosphatic shell casts obtained from Boligee in Greene county, and from a locality between Newberne and Uniontown, seven miles from the first named place. Both of these localities are situated at some distance from the border of the Rotten Limestone.

Analyses illustrating the composition of the phosphatic materials occurring in the Rotten Limestone itself are given in the table (page 44), numbers 111 to 120 inclusive.

The phosphates of the strata which overlie the Rotten Limestone and which are included in the Ripley group have been examined from a number of localities below noted, and their description may perhaps be best given in geographical order. In describing the specimens, I shall endeavor to mark, as far as it is possible to do so, their geological position also by referring them to one of the four divisions of the Ripley group given on a preceding page.

Sumter County.--At Livingston, in addition to the phosphatic materials already mentioned as occurring in the Rotten Limestone itself, there is, at the negro graveyard about two and a half miles south-east of town, an outcrop of a siliceous limestone or calcareous sandstone strongly phosphatic, and a good many feet below it a clayey limestone with about half a per cent of phosphoric acid. The siliceous rock lies upon a hill of considerable height, and probably belongs to the upper part of the fourth or the lower part of the third division above given. The argillaceous limestone probably belongs to the Rotten Limestone. Analyses of these rocks are given in the table (page 44), numbers 118 and 121. Just across the bridge over Sucarnochee, on the road to York, the argillaceous limestone with phosphatized shell casts (third division above) outcrops along the road leading up the hill. None of these have been analyzed, but they are of the usual character.

At Coatopa the same clayey limestone may be seen on the land of Mr. John Wiatt. This rock has a good deal of glauconite and is highly fossiliferous, the fossils being mostly in the form of phosphatized casts. Analyses both of the limestone and of the shell casts have been made, numbers 122 and 123. In the same locality there is a highly calcareous greensand marl, full of lumps of pulverulent carbonate of lime. This material, by reason of its comparatively high percentage of phosphoric acid, as well as of carbonate of lime, will make an excellent fertilizer, where it can be had without much cost for freight. Analyses, numbers 124, 125 and 126, (page 44).

At Moscow, on the Tombigbee River, the strata of this horizon outcrop on the banks of the river. Here we have the siliceous rock, the clayey limestone and the shell casts, and a few miles north of the town, at Dr. Kelly's, the greensand marl. Analyses, numbers 127. 128, 129, (p. 44).

Marengo County.—In Marengo county the rocks of this horizon may be followed along a line leading from Moscow through Jefferson, Nixon's Store, etc. They occur near C. C. Shields, south of Dayton, and all along the Linden and Prairie Bluff road to the eastern border of the county. The materials which have been analyzed come, in this county, from two horizons, viz: The upper strata of the Rotten Limestone or the immediately overlying beds of the Ripley, and the sandy beds which form the uppermost division of the Ripley as above indicated.

1. Immediately south of the town of Dayton the soil is a strongly tenacious calcareous clay, imbedded in which are numerous clayey phosphatic concretions which are different from anything seen elsewhere. If found in sufficient quantity, these could no doubt be utilized, since they contain a very considerable percentage of phosphoric acid, as shown by the subjoined analyses, numbers 130 and 131, (page 44).

2. In the uppermost beds of the Ripley group, which are in the main yellow micaceous sands, there are at intervals beds of shells, or rather of the casts of shells, in some cases five or six feet in thickness. These shell casts are almost pure phosphate of lime, and as they are loosely imbedded in the sands and in large quantity, they may undoubtedly

be dug out, ground up and used with profit. Near Mr. Baileys's, between Dayton and Linden, there is at the Capt. Saunders place a thick bed densely packed with these shell casts. Also near C. C. Shields, on the road to Prairie Bluff, and on the Shiloh road there are many cuts worn by the roads in the yellow sands, and in these cuts these shell beds appear. An analysis of some of the casts from this locality appears on page 44, number 132.

Further south also in T. 15, R. 4, in a belt running east and west through the second tier of sections of the township, these shell beds are met with in many localites. One of the analyses (page 45) shows the composition of an average of the shell casts from three localities on Thos. Boozer's land. Number 133. These, as well as most of the clayey phosphates from near Dayton, were collected by Mr. Lawrence R. Smith, to whom I am also indebted for much information concerning the occurrence of the phosphatic material in Marengo county.

These shell casts appear to promise more than any of the other materials observed in Marengo, for they are found in sufficient quantity, are easily accessible, and if the composition in other localities is approximately similar to that of the specimens analyzed, they are rich enough in phosphoric acid. It seems probable that they will all be found to be very highly phosphatic, since the specimens from near Rehobeth from the same geological horizon show a similar composition. See analysis number 139, (page 45).

Wilcox County.—This phosphatic belt may be traced all along the northern border of the county from Prairie Bluff to Snow Hill. The phosphates appear to come from three distinct geological horizons, viz:

1. The argillaceous limestone with shell casts which make up the third division of the Ripley group. Everywhere at this horizon hard brown colored shell casts of phosphate of lime are seen wherever the limestone has been exposed to weathering. Samples of these phosphatic casts have been collected from Prairie Bluff, Old Canton Landing and vicinity, near Bridgeport, at mouth of Tear Up Creek,

and eastward out to Snow Hill, and associated with them at all these localities we find hard crystalline phosphatic limestone and calcareous sandstone, the limestone being in places very siliceous, so as to approach sandstone in composition. We have no analyses of the shell casts from Wilcox, but they are in all respects like those from Coatopa and other localities along this belt. At Prairie Bluff there is a sandstone much used for building purposes, which has a good deal of phosphoric acid, averaging perhaps .5 of a per cent. See analysis (page 45), No. 134.

The siliceous limestone, which may be a variety of the preceding, is more strongly phosphatic, and a specimen from a locality about a mile north of Prairie Bluff contained over 8 per cent. phosphoric acid. No. 135. A similar phosphatic sandy limestone from John Pettway's land, in Gee's Bend, has even more. See No. 137, (page 45).

A somewhat similar rock, but less strongly phosphatic, was analyzed from Mr. J. T. Beck's land near Bridgeport. No. 136, (page 45).

Again, at Snow Hill the same rock, a specimen of which from L. Moore contains nearly 10 per cent. No. 142, (page 45).

2. In the upper strata of the Ripley group in all these localities occur the phosphatic shell casts, analogous to those described from near Shields, in Marengo, and in the eastern part of the county near Snow Hill, the phosphatic greensand, which is probably analogous to that occurring at Coatopa and near Moscow. Some of the shell casts from Rehobeth, a few miles north of Prairie Bluff, have been analyzed and contain over 23 per cent. of phosphoric acid. No. 139. Associated with these casts are numerous rounded lumps of a sandy calcareous character containing some phosphoric acid. No. 138, (page 45).

The greensand has been best tested, both by analysis and by actual field experiment, from the bed occurring at W. S. Purifoy's, Snow Hill. This contains about 1.5 per cent of phosphoric acid, but a large percentage of carbonate of lime in loose, easily crumbled form, and will be one of the most valuable of natural fertilizers where it can be spread upon the soil without too much expense. See No. 140, (page 45). This is analogous to the greensand marl from near Coatopa, and from various localities in Dallas contiguous to the Wilcox line, as shown below.

There is an indurated bed usually associated with the greensand which contains even a higher percentage of phosphoric acid, as may be seen from the analysis No. 141, (page 45).

Dallas County.—The same rocks occur along the southern line of this county at Tilden, Richmond, Carlowville, Minter Station, etc., where we find both the greensand bed and below it the siliceous phosphatic limestone or calcareous sandstone, of which several analyses are presented. From these it will be seen that the limestone has a very variable composition. Nos. 144, 145, 146, 147, 151, 152, 154, (pages 45-6). With this are everywhere found phosphatic shell casts. No. 153, (page 46). The greensand marl appears to be of more uniform composition, as shown by analyses Nos. 143, 148, 149, 150, (pages 45–6).

Lowndes County and Eastward.—Beyond Dallas county very few examinations have been made, but some specimens have been sent to the University which show the existence of this line of phosphatic rocks nearly to the eastern line of the state. The phosphatic greensand crosses Lowndes a short distance below Bragg's Store.

Between Fort Deposit and Calhoun Stations the siliceous limestone occurs sometimes in rounded, apparently waterworn fragments, one of which has been analyzed. No. 155, (page 46).

Again, at Strata, in the northern part of Crenshaw county, we find the same rock. Analysis No. 156, (page 46). Along with it are great numbers of phosphatized shell casts.

At Olustee Creek, in northern Pike, a limestone with a moderate proportion of phosphoric acid has been found, but the main phosphatic belt will probably be found further north in the lower part of Montgomery county. See analysis 157, (page 46).

The crystalline limestone of Chunnenugga Ridge at Union Springs, in Bullock county, is also phosphatic, as well as the limestone cropping out on the banks of Cubahatchee Creek in Macon county. No. 162 and 163, (page 46).

From Dr. C. B. Leitner, Flora, Bullock county, I get a number of specimens of a phosphatic clay marl, which although not very rich in phosphates, might yet be advantageously used where the cost of transportation and application to the soil would not be too great. For analyses see Nos. 158, 159, 160, 161, (page 46).

Along the Chattahoochee river, phosphates, nodules, etc., have been observed in small quantities at several places, *e. g.*, near mouth of Uchee Creek, on Mr. Blackman's place above Eufaula, etc., but no analyses have yet been made of them.

The tables on pages 44-6 show at a glance the composition of the various materials above mentioned. They are arranged first, as to their geological horizon, and secondly, as to geographical position. The several materials are (beginning with the lowermost, geologically): 1st, a siliceous limestone of very variable composition, with which are associated numerous phosphatized shell casts. This appears at Moscow, at Prairie Bluff, in Gee's Bend, at Minter Station and at Snow Hill.

Above this we find in many of the localities a fine greensand marl containing about 1.5 per cent of phosphoric acid, *e. g.*, at Coatopa, near Moscow, at Tilden, and at Snow Hill. At Eufaula the dark gray micaceous marls have a small percentage of phosphoric acid. Analyses 164, 165, 166, p. 46. In these micaceous sands the greensand bed is located. The greensand is the most valuable of all the materials occurring in the Upper Cretaceous, unless it should turn out that the shell casts occurring in the uppermost sands (*e. g.*, at O. C. Shields and Bailey's, in Marengo, and near Rehobeth, in Wilcox,) are present in very great quantity, and, as now seems to be the case, very generally distributed throughout the country. This bed lies at a considerable distance above the siliceous limestone and shell casts above mentioned, the distance between the two being probably over 100 feet. The cast themselves are easily pulverized, unlike those occurring in the lower bed.

Phosphatic Materials from the Livingston, Coatopa, Snow Hill and Union Springs Belt.

NUMBER AND NAME.	Insol'ble Matter.	Phosphoric Acid.	Bone Phosphate.	Lime.	ANALYST.
A.—Rotten Limestone.					
111. Nodules and shell casts, 7 miles south of Newberne	3.59	20.68	45.16	......	A. & M. College Laboratory.
112. Fossil casts from Boligee	2.98	27.76	49.68	......	" " "
113. Near railroad bridge in Livingston	11.90	.20	.43	......	" " "
114. Hill, 3¼ miles from Livingston, on Jones' Bluff road	53.16	.41	.86	......	" " "
115. Siliceous lime rock 4⅛ miles north of Livingston	39.52	.50	1.09	......	" " "
116. Concretionary nodules 3¾ miles north of Livingston	8.48	1.10	2.60	......	" " "
117. White clayey limestone 4 m. s-e. of Livingston, J. J. Lee's	13.90	2.58	5.62	......	" " "
118. Clayey limestone, Negro graveyard, 2½ m. s-e. Liv'ton	25.30	.56	1.22	......	" " "
119. Clayey limestone, 6 m. s-e. of Liv'ton, Black Bluff road	15.02	.64	1.39	......	" " "
120. Phosphatic shell casts, same locality as 119	11.65	9.92	21.65	......	" " "
B.—Ripley Group, Overlying Rotten Limestone.					
121. Siliceous rock, Negro graveyard, 2½ m. s-e. Livingston, Sumter county	......	7.30	15.91	......	Eug. A. Smith.
122. Shell casts and nodules, Jno. Wiatt's, Coatopa	9.38	14.56	31.78	......	A. & M. College Laboratory.
123. Clayey limestone with greensand, same locality	25.74	5.01	10.93	......	" " "
124. Clayey phosphatic marl, same locality	51.25	2.24	4.89	......	" " "
125. Clayey phosphatic marl, another variety, same locality	......	.72	1.57	......	Eug. A. Smith.
126. " " " " " "	......	.74	1.61	......	" "
127. Siliceous rock, river bluff, below Moscow, Sumter co.	57.00	.28	.53	......	A. & M. College Laboratory.
128. Shell casts, " " "	25.52	1.55	3.38	......	" " "
129. Greensand marl, Dr. Kelly's, few m. n. of Moscow, "	......	2.52	5.50	......	" " "
130. Clayey concretions, white, in soil just south of Dayton, Marengo county	11.02	10.93	23.83	......	D. W. Langdon, Jr.
131. Clayey concretions, dark gray, just south of Dayton, Marengo county	21.41	17.32	37.76	......	" "
132. Shell casts, C. C. Shields', near Dayton, Marengo county	......	19.00	41.62	......	Eug. A. Smith.

Phosphatic Materials from the Livingston, Coatopa, Snow Hill and Union Springs Belt.—Continued.

NUMBER AND NAME.	Insol'ble Matter.	Phosphoric Acid.	Bone Phosphate.	Lime.	ANALYST.
133. Shell casts, T. J. Boozer's, T. 15; R. 4, Marengo county	......	25 43	55.43	....	Eug. A. Smith.
134. Calcareous sandstone, average of three analyses, Prairie Bluff, Wilcox county	......	.48	1.05	....	“ “
135. Calcareous sandstone, 1 mile north of Prairie Bluff, Wilcox county	......	8.35	18.20	....	“ “
136. Gray calcareous rock, J. T. Beck, near Bridgeport, Wilcox county	......	1.08	2.34	....	“ “
137. Phosphatic limestone, J. H. Pettway, Gee's Bend, Wilcox county	......	12.49	27.23	....	“ “
138. Sandy calcareous lumps, near Rehobeth, Wilcox co.	......	.40	.87	....	“ “
139. Phosphatic shell casts, near Rehobeth, Wilcox county	......	23.52	51.28	....	“ “
140. Phosphatic greensand, W. S. Purifoy, Snow Hill, Wilcox county	40.83	1.04	2.37	....	D. W. Langdon, Jr.
141. Indurated greensand, W. S. Purifoy, Snow Hill, Wilcox county	28.61	3 94	8.59	....	“ “
142. Sandy phosphatic limestone, L. Moore, Snow Hill, Wilcox county	32 47	9.74	21.23	....	“ “
143. Phosphatic greensand, J. B. Lang, Tilden, Dallas co	....	1.5	3.27	16.36	Eug. A. Smith.
144. Glauconitic limestone, J. Z. Hearst, Richmond, Dallas county	15.73	2.62	5.72	....	A. & M. College Laboratory.
145. Siliceous limestone, J Z. Hearst, Richmond, Dallas co.	34.95	3 21	7.00	.....	“ “ “
146. Siliceous limestone, J. Z. Hearst, Richmond, Dallas co	40.16	5.94	12.96	....	“ “ “
147. Siliceous limestone, Dr. G. W. Kyser, Richmond, Dallas county	39.47	8.69	18 97	29 31	“ “ “
148. Greensand marl, from Dr. G. W. Kyser, Richmond Dallas county	35.23	1.43	3 22	18.66	D. W. Langdon, Jr.
149. Greensand marl, from Dr. G. W. Kyser, Richmond, Dallas county	37 98	1.24	2 70	16 88	“ “

Phosphatic Materials from the Livingston, Coatopa, Snow Hill and Union Springs Belt.—Continued.

NUMBER AND NAME.	Insol'ble Matter.	Phosphoric Acid.	Bone Phosphate.	Lime.	ANALYST.
150. Greensand marl, from Wade, Carlowville, Dallas co.	37.20	1.16	2.53	17.92	D. W. Langdon, Jr.
151. Glauconitic limestone, H. M. Smith, Minter Station, Dallas county	17.38	.74	1.62	......	A. & M. College Laboratory.
152. Siliceous limestone, Col. N. H. R. Dawson, Minter Station, Dallas county	42.46	1.43	3.12	......	" " "
153. Phosphatic shell casts, Col. N. H. R. Dawson, Minter Station, Dallas county	10.72	16.90	36.80	......	" " "
154. Phosphatic limestone, Col. N. H. R. Dawson, Minter Station, Dallas county	....	12.41	27.05	....	John Daniel.
155. Sandy crystalline limestone, Ft. Deposit, Lowndes co.	......	13.55	29.54	....	Eug. A. Smith.
156. Sandy crystalline limestone, Strata, Crenshaw county.	....	6.22	13.86	....	Eug. A. Smith.
157. Sandy crystalline limestone Olustee creek, Pike county.	41.96	1.14	2.49	....	A. & M. College Laboratory.
158. Dark colored clay marl, C. B. Leitner, Flora, Bullock county	87.25	.53	1.16	1.15	" " "
159. Yellow colored clay marl, C. B. Leitner, Flora, Bullock county	67.25	.81	1.76	12.02	" " "
160. Dark colored clay marl, C. B. Leitner, Flora, Bullock county	77.48	.76	1.66	8.20	" " "
161. Dark gray clay marl, C. B. Leitner, Flora, Bullock county	77.02	.66	1.44	12.32	" " "
162. Hard limestone, 9 miles south of Tuskegee (mean of 3 analyses) Macon county	......	.38	.82	......	" " "
163. Hard limestone, on Cubahatchee creek, Macon county.	....	.51	1.11	....	" " "
164. Gray micaceous sandy marl, J. W. Tullis, Eufaula, Barbour county	80.14	.44	.96	....	D. W. Langdon, Jr.
165. Light gray, indurated sandy marl, J. W. Tullis, Eufaula, Barbour county	....	.18	.39	....	" "
166. Gray micaceous sandy marl, J. W. Tullis, Eufaula, Barbour county	76.19	.27	.59	....	" "

THE TERTIARY FORMATION.

General Characters and Sub-Divisions.

The whole thickness of the strata of the Tertiary formation on the Alabama and Tombigbee Rivers is between 1,620 and 1,700 feet, while on the Chattahoochee it is about 1,200 feet.

We have adopted the following four-fold division of the Tertiary:

(4) The White Limestone.
(3) The Claiborne.
(2) The Buhrstone, and
(1) The Lignitic.

The general characters of these sub-divisions are given below in the order of their relative ages, *i. e.*, beginning with the oldest.

(1) THE LIGNITIC.

This is the most massive of the sub-divisions of the Tertiary, having a thickness which can hardly be less than 900 feet. It also presents a greater variety in mineral composition, as well as in fossils, than the other divisions. In the most general terms, the Lignitic strata are cross-bedded sands, thin bedded or laminated sands, laminated clays and clayey sands, and beds of lignite, as well as liginitic matter which merely colors the sands and clays. With these are found inter-bedded at several horizons strata containing marine fossils. For the sake of greater convenience of description we present this Lignitic division in seven sections, each of which is characterized by one or more beds of marine fossils included in it. These sections are as follows, beginning with the lowest or oldest:

(a) The Midway or Pine Barren section; Clayton limestone.—The thickness of this section along the Alabama and Tombigbee Rivers is perhaps 25 feet. The strata are a white argillaceous limestone holding a large fossil of the nautilus family, which is characteristic of the horizon, calcareous sands and a crystalline limestone with *turritellas*, *carditas* and *corals*. This section is best seen in eastern Wilcox on Pine Barren Creek, and in adjoining part of Butler in the Little Texas region, but the upper or Nautilus rock occurs at Midway on the Alabama River and westward across Marengo. In going eastward we find the rocks of this section increasing in thickness till on the Chattahoochee it includes over two hundred feet in thickness of limestones and other calcareous strata.

(b) The Black Bluff section.—We find some difficulty in determining the exact thickness of the strata of this section, since on the Tombigbee the strata outcrop over a surface which would, with uniform dip, correspond to a thickness of over two hundred feet; while on the Alabama, and more particularly inland in the eastern part of Wilcox county, the thickness is not greater than thirty-five or forty feet. Since 80 feet of these beds are seen in superposition at one locality, (Black Bluff) we think that the maximum thickness cannot be less than one hundred feet.

The characteristic strata of nearly the whole of this section are black or very dark brown clays, which are in part fossiliferous. These clays underlie the *Flatwoods* of western Alabama and Mississippi, but towards the east they become much more calcareous and form the basis of some fine farming lands with black limy soils. This section has not been identified eastward of Butler county.

(c) The Naheola and Matthews' Landing section.—It is difficult to give the exact thickness of the strata of this section also, since it varies on the two rivers Alabama and Tombigbee, and thins down towards the east and does not appear at all on the Chattahochee. We have placed the thickness at one hundred and thirty to one hundred and fifty feet; the strata are gray sandy clays in the main, alternating with cross bedded sands. The beds of dark sandy and glauconitic clays containing marine fossils lie at the base of the section. At Naheola, on the Tombigbee, the upper and more glauconite part of the bed is most prominent, while at Matthews' Landing, on the Alabama, the lower part of the bed, dark gray sandy clays form the bluff.

(d) The Nanafalia and Coal Bluff section.—The strata of this section are 200 feet in thickness and consist of about 50 feet of gray sandy clays at top, which show a tendency to indurate into tolerably firm rocks resembling very closely some of the strata of the Buhrstone. Below this, about eighty feet of sandy beds, often strongly glauconitic characterized throughout by shells of a small oyster, *Gryphæa thirsæ*. Near the base of this sandy division there is a bed about twenty feet thick literally packed with these shells. Below the Gryphœa thirsæ beds follow some seventy feet of cross-bedded sands, glauconitic and apparently devoid of fossils, including about ten feet above the base of the section, a bed of lignite which varies in thickness from four to seven feet, The Nanafalia section retains its thickness and general character across the state to the Chattahoochee.

(e) The Bell's Landing or Tuscahoma section.—This is 140 feet in thickness on the Alabama and Tombigbee rivers, and this thickness is retained across the state to the Chattahoochee. The lithological characters also are practically the same throughout, but in the western part of the state the section includes two important beds of marine fossils and a third quite small and apparently unimportant. Towards the east these beds disappear. These fossiliferous beds are interstratified with yellowish sands in the upper and rather heavy bedded sandy clays in the lower part of the section. The upper marine bed, called the Bell's Landing marl, is about ten feet in thickness, and has forty feet of sandy strata over it. The middle bed is called the Gregg's Landing marl, and it is twenty to twenty-five feet below the preceding; it is about five feet in thickness. The lowermost of the fossiliferous beds of this section is only about one foot in thickness and lies about fifty feet below the Gregg's Landing bed. It is highly glauconitic, but does not contain any great variety of fossils. The Bell's Landing marl is distinguished from all others in Alabama by the great size of the shells which it contains. Eastward of the Alabama river there are very few fossils to be seen in the strata of this section.

(f) The Wood's Bluff or Bashi section.—This is 80 to 85 feet in thickness. The uppermost 30 feet consist of brown clays passing into a greensand, which holds a great variety of finely preserved marine shells. Below this greensand marl are dark gray sandy clays with four or five thin beds of lignite within the first twenty-five feet, succeeded by about 30 feet of cross-bedded sands, with a two foot seam of lignite at the base. This section extends entirely across the state to the Chattahoochee, where it is, however, considerably less in thickness and comparatively wanting in well preserved fossils.

(g) The Hatchetigbee section.—This section is 175 feet in thickness and is made up of sandy clays of prevailing brown colors varied with purplish shades, and containing three or four beds of marine shells in the uppermost 75 feet, and of somewhat similar purplish brown clays nearly devoid of fossils in the lower 100 feet. All these brown sandy clays become much lighter colored upon drying and exposure to the weather. These clays extend across the state with somewhat diminished thickness, till on the Chattahoochee they are perhaps not thicker than 50 feet and are practically devoid of fossils.

2. THE BUHRSTONE.

The minimum thickness of this formation is 300 feet; the materials are almost altogether aluminous and siliceous, consisting of aluminous sandstones, claystones and quartzitic sandstones, with occasional thin beds of glauconitic sand. The few fossils which have been obtained from this division are mostly in the form of casts. They do not appear to differ specifically from that of the overlying division. On the Chattahoochee the thickness is less than 200 feet and the rocks are much more calcareous and hold a greater number and greater variety of fossils.

3. THE CLAIBORNE.

The thickness is 140 to 145 feet; the materials are sands and clays, which are generally calcareous and often glauconitic. Near the top of the sub-division is a bed of glauconitic sand, 15 to 17 feet in thickness, filled with shells in a perfect state of preservation. The sandy clays forming the lower 50 feet are likewise filled with a great variety of shells in a good state of preservation. The intervening calcareous clays and calcareous sands are distinguished by the great number of shells of *Ostrea sellæformis* which they hold, as well as by the comparative rarity of other forms. On the Chattahoochee the thickness is not greater than 75 feet, and the bed with Ostrea sellæformis appears to be the only representative.

4. THE WHITE LIMESTONE.

This subdivision is calcareous throughout, but the lowermost 60 feet are more argillaceous than the rest. The minimum thickness is 350 feet, of which the uppermost 150 feet consist of a tolerably pure but somewhat siliceous limestone filled with coral masses.* The next succeeding 140 feet or more are made up of a soft white limestone, often quite pure and filled with *Orbitoides Mantelli.* The lowermost 50 feet are of impure, argillaceous limestone, which in disintegrating yields a black calcareous soil similar to that derived from the Rotten Limestone of the Cretaceous. This lower portion of the White Limestone surpasses the others in the variety of its fossil contents. On the Chattahoochee the rocks are more uniform in composition and are about 275 feet in thickness.

Phosphates of the Tertiary Formation.

In the summer of 1884 Mr. D. W. Langdon, Jr., of the State Geological Survey, discovered at St. Stephens, and subsequently at several other localities, representing different geological horizons, phosphatic marls and nodules. Since that time other examinations have disclosed the fact that phosphatic material exists in at least four different geological horizons, viz: In the Black Bluff and Nanafalia groups of the Lignitic; in the White Limestone; and in eastern Alabama, at Ozark, in the strata of the Claiborne group.

1. *Black Bluff Group.*—In the eastern part of Wilcox county the prairie clays derived from the disintegration of this group are highly fertile, and though no analysis of any

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*This upper part appears to be entirely local and has not been seen except in Clark county, below Jackson. Leaving this out of account, the thickness of the white limestone is some 200 to 300 feet.

of these soils has yet been made, it is probable that they are exceptionally strong in phosphoric acid, for they are in places filled with irregularly shaped concretions or *coprolites* which are chiefly phosphate of lime. One of these specimens analyzed by me, from the mouth of Bonner's Lane, contains 27.632 per cent of phosphoric acid, equivalent to 60.238 of bone phosphate. Analyses No. 167 (page 55). Immediately above the clays here alluded to are several sandy beds, which, in part, are pretty firm sandstones. One of these sandstone beds is more persistent than the others, and appears along the hillsides, near Allenton and elsewhere in eastern Wilcox, in little cliffs which look like low walls. This rock has in places a large number of phosphatic concretions, very like those above described as occurring in the clays below. I have made two analyses of this rock, the one from the "Grave Yard Hill," a few miles west of Allenton on the upper Camden road, and the other from the mouth of Bonner's Lane. Both are hard, yellowish, sandy limestones, that from the first locality being pretty free from the phosphatic nodules, that from the other containing a notable quantity of them. The rock from the Grave Yard Hill had 0.3 per cent. of phosphoric acid only, while that from Bonner's Lane contained 3.71 per cent. Analyses No. 168, 169, (page 55).

This formation runs eastward into Butler, where, however, it has not as yet been examined.

2. *The Nanafalia Group.*—The important bed in this division of the Lignitic is a deposit of shells of a small oyster, called *Gryphœa thirsæ.* While this shell is found generally distributed through sixty feet or more of the strata, there are in most localities of its occurrence beds from 15 to 20 feet in thickness, consisting of an almost solid mass of these shells packed in greensand. At intervals in these beds there are bands much harder than the rest of the beds, and these hardened bands appear to be generally pretty strongly phosphatic. Mr. Langdon analyzed a specimen from Nanafalia of one of these hard ledges and found 6.701 per cent of phosphoric acid in it. Analyses No. 170, (page 55).

The softer parts of this marl, as well as of the other marls which characterize the Lignitic division of the Tertiary, appear, as a rule, to have a very inconsiderable percentage of phosphoric acid. Several of them, however, would make good fertilizers because of the large amount of pulverulent carbonate of lime which they hold; especially is this the case with the Nanafalia and Wood's Bluff marls.

3. *The Claiborne.*—In the eastern part of the state the Claiborne division of the Tertiary includes in places a bed of shell marl, which holds a very considerable percentage of phosphate of lime. This bed is best seen in the cut made by the Midland railroad, a short distance from Ozark in Dale county, where this road passes under the Savannah & Western R. R. (Georgia Central). This bed about five feet in thickness contains also a large amount of carbonate of lime, and would unquestionably benefit the soils about Ozark if spread liberally upon them.

The section exposed here is as follows:

(1)	Gray surface sands	3 to 4 feet.
(2)	Red clay loam	6 to 8 "
(3)	Light colored laminated clay	5 "
(4)	Dark bluish pyritous sands	5 "
(5)	Black or dark gray joint clay	3 "
(6)	Greensand marl filled with shells, which are mostly of one species, a *cytherea*. This bed is phosphatic	5 "
(7)	Black sandy clay to bottom of the cut	4 "

The bed No. 6 is the one referred to, and though it has been seen by me only at this place, there is no doubt that it underlies a large area and will be found outcropping along the ravines about Ozark.

4. *The White Limestone.*—In the lower beds of this formation at St. Stephens, Mr. Langdon first saw the phosphatic marl. It occupies the lower fifty or sixty feet of the division, corresponding to the Jackson formation of Hilgard and other writers. In this limestone there are phosphatic marls, as well as nodular masses of phosphate of lime. Where the disintegrated marl forms the surface, a very productive and

lasting soil is the result. The fertility of the soils of the "Lime Hills" of Clarke, Washington and Choctaw counties is well known, and the same class of soils is found in the prairies of western Mississippi, which join the lime hill regions of Washington and Choctaw. In this state the topography of the region is rather broken, so that the soil washes badly.

The marl first analyzed from St. Stephens contains 1.14 per cent. of phosphoric acid, and a nodular mass from the same locality contains 22.68 per cent., or about as much as the average nodules of the Cretaceous formation. Nos. 171 and 172, (page 55).

A cream colored calcareous rock from near Coffeeville, of presumably the same horizon, contains 2.743 per cent. No. 173, (page 55).

In many places in Clarke county, where the lower part of the White Limestone forms the surface, these nodules are common. One has been analyzed from near Grove Hill, having 19.48 per cent. of phosphoric acid. No. 174(page 55.) I have, however, nowhere seen them in sufficient quantity to make them of any importance. The marl, on the other hand, might be very advantageously used where it is convenient to the fields upon which it could be spread without too great cost.

The upper part of the White Limestone seems to be comparatively barren of phosphatic materials. The average of a good many analyses made of this rock shows no more than about 0.1 per cent. of phosphoric acid.

So far as examined up to this time, none of the Tertiary materials of Alabama are very promising for phosphates. Florida, on the other hand, abounds in phosphatic limestone and marl, but they are, in all probability, in every case, of Miocene age, later than the Tertiary of Alabama. Examinations made of the Eocene limestone of Florida (of same age as the Alabama rock) likewise show very little of phosphoric acid.

None of the materials from the Claiborne and Buhrstone divisions, except the shell bed at Ozark, Dale county, above mentioned, have as yet shown any notable amount of phosphate.

The following table will show the composition of the phosphatic materials from the Tertiary formation:

Table of Analyses of Phosphatic Materials from the Tertiary Formation of Alabama.

NAME AND LOCALITY.	Insol'ble Matter.	Phosphoric Acid	Bone Phosphate.	Lime Carbonate.	ANALYST.
167. Phosphatic nodule, Lignitic group, Bonner's Lane, Wilcox county	.....	27.63	60.21	......	Eug. A. Smith.
168. Phosphatic sandstone, Lignitic group, Bonner's Lane, Wilcox county	....	3.71	8.00	......	Eug. A. Smith.
169. Phosphatic sandstone, Lignitic group, near Allenton. Wilcox county	....	.30	.65	....	Eug. A. Smith.
170. Indurated marl, Lignitic group, Nanafalia, Marengo county	19.31	6.70	14.61	....	D. W. Langdon, Jr.
171. Phosphatic marl, white limestone, St. Stephens, Washington county	12.00	1.14	2.47	68 32	"
172. Phosphatic nodule, white sandstone, St. Stephens, Washington county	4.51	22.68	49.45	13 79	"
173. Phosphatic rock, white limestone, near Coffeeville. Clarke county	6.44	2.74	5.98	72 01	"
174. Phosphatic nodule, white limestone, Grove Hill, Clarke county	1.55	19.48	42.47	....	"

PROBABLE ORIGIN OF PHOSPHATES.

The phosphates above described, especially those of the Cretaceous formation, in their geological position, mode of occurrence, and in the character of the material, resemble the phosphates of Cambridgeshire, England. These are found at several horizons in the formations immediately underlying the Chalk, viz: the Upper Greensand, the Gault, and the Neocomian, or Lower Greensand; the phosphate or "coprolite" beds appear always to mark horizons of unconformity, i. e., they seem to have been deposited upon the eroded surfaces of previously existing strata; they consist of casts of shells, bones, etc., mineralized by phosphate, and of shapeless masses of phosphate of lime; they are irregularly distributed through the matrix along with pebbles and other rolled masses; and many of the phosphatized casts are of fossils which belong to earlier formations than those of which they now form a part. (See T. G. Bonney, Cambridgeshire Geology, and W. Keeping; the Fossils of Upware, etc.)

So our Alabama phosphates of the Cretaceous formation occur at several horizons, and they occur at planes of unconformity. This is particularly noticeable in the case of the phosphates at the base of the Rotten Limestone. In western Alabama, along the Tombigbee River, from 800 to 1000 feet of Lower Cretaceous beds underlie the Rotten Limestone, the northern outcrop of which is at least thirty miles from the Coal Measures at Tuscaloosa, while eastward these underlying beds seem to thin out so that at Wetumpka the phosphate bearing beds almost lap over upon the Metamorphic rocks.

The fossil casts are worn into most irregular shapes, and are associated with the bones of saurians and the teeth of sharks. These phosphates are mingled with rolled or waterworn fragments of other rocks; especially is this the case in the southern phosphate belt. At Fort Deposit, or just south of it, is a ridge which owes its existence to the hard crystalline limestone of the Ripley group; the foot of this, and the plain north of it for several miles, are strewn with rounded and water-worn fragments of this siliceous limestone.

The specimen from Fort Deposit, of which an analysis is given above, was one of these rounded and water-worn fragments.

The same thing may be noticed at Strata, and probably at very many other similar localities. Speaking of the Chunnenuggeo Ridge at Union Springs, Prof. Toumey says: "The north side of the ridge presents the appearance of an ancient sea-beach, waterworn, detached masses of limestone and calcareous sandstone, imbedded in sand, and presenting the appearance of having been washed for ages by the ocean waves." (2d Report on the Geology of Alabama, p. 136.)

It is thus seen that in all these respects the Alabama Cretaceous phosphate beds resemble those of England, and it is quite probable that many of the phosphatic shell casts are "derived" fossils, that is, they have been washed out of the beds of which they originally formed a part, and redeposited in the beds where they are now found. To decide this question, a thorough study of our Cretaceous fossils will be needed.

In South Carolina a very similar state of things exists, only the main phosphate beds are of Tertiary, or later, instead of Cretaceous age.

The explanation of the origin and mode of formation of the phosphatic deposits now most generally accepted, is that originally presented by Prof. Holmes, of Charleston, which is thus well summarized by Dr. U. C. Shepard, Jr.: "Accumulations of decomposed animal detritus and exuviæ were acted upon by carbonic acid water, which dissolved out the phosphates and transported them into calcareous earth, where they were precipitated and fixed by carbonate of lime.

This process was continued till the carbonate of lime was transformed into a rich phosphate of lime. The mass, originally soft and loose, hardened gradually, but under the wear and roll of water it was broken up and rounded into the phosphatic pebbles now found."

Prof. T. G. Bonney, (Geology of Cambridgeshire,) has given the following account of the process: "With regard to the mode of formation of these phosphatic casts, nodules, etc., we have to consider not only the probable source of the phosphate, but also the mode in which it has been concentrated into these "coprolites." Phosphate of lime in the form of the mineral *Apatite* is present in granite, gneiss, slate, talc, and chlorite schists, and several kinds of lava..... It is also present in the waters of numerous mineral springs. .... It has been detected in the waters of several rivers, and is probably present in all, as well as in the sea, though of course in small quantities. Again, phosphates (chiefly lime) are present in marine and other plants. In short, the various investigations that have been made show that it is almost universally present in organic and not unfrequently in inorganic bodies."

"Next, it has been shown by numerous experiments that phosphate of lime is soluble in carbonated water, and further, that phosphate of lime present in an organism, (plant or animal) is much more soluble than that in a mineral."

"Again, phosphate of lime dissolved in carbonated water is precipitated by ammonia, which is a result of decomposition of organic bodies." "It appears, then, to me, that the best explanation of these phosphatic nodules is to consider them formed by what, for want of a better name, we may call concretionary action. The excreta, softer tissues, and smaller bones of the Vertebrata, the bodies of numerous Invertebrata, many of which have left no other trace behind, the various marine plants which probably would flourish abundantly in a shallow sea, to say nothing of any apatite which might be present in the detritus wherein they were entombed, would furnish a considerable supply of phosphates; in fact, *cœteris paribus*, a shallow sea appears to me more likely to be rich in phosphates than a deep one. The phosphates of the more perishable parts of the above named organisms would be dissolved in the water permeating the mud of the sea bottom, which would also be supplied with carbonic acid from decomposition, and so the mud be saturated with a weak solution of phosphate of lime. Now, if at a certain point in the mud there were an excess of phosphate of lime, and especially if ammonia were being evolved at that point, the phosphate in the neighboring solution might be precipitated; and probably (for it seems to have often happened with other minerals) all the phosphates of the surrounding mass would be precipitated about the nucleus. I regard, then, these nodules as the result of a process which took place during a part of the Gault period, and was continued during the Greensand epoch; which began shortly after the death of the organism, and lasted for a long time; and I explain their abundance, as I have already said, by considering the seam as the riddlings of a considerable deposit. It is note-worthy how often a bed of phosphate nodules comes just above a more or less marked stratigraphical break. It appears to me, therefore, that the process of formation of these nodules is......very analogous to that of flint; both, in many cases, proceeded from the mineralization of sponges."

"It may not unfairly be asked, why, seeing that weak solutions of phosphate of lime must be almost always present in sea-water, are not phosphate nodules generally present in rocks. The answer to this is that phosphate nodules are far from rare, and that the difficulty is exactly of the same kind as exists in the formation of flint."

"It may be that local circumstances, as indicated above, have been favorable to slightly concentrating the phosphatic element in the sea-water; but without availing ourselves of this possibility we may fairly answer that the process of deposition from weak solutions, one of which we are very ignorant, is probably a complex process which requires several independent conditions to be fulfiled, so that it is but rarely that all are satisfied."

I have spoken above of the circumstances that casts of fossils are generally phosphatized, while those fossils, especially those of the oyster family, which retain their original shells, show scarcely a trace of phosphoric acid.

The purer limestones also, (i. e. those containing least clayey matters,) are usually very slightly, if at all, phosphatic. This circumstance is accounted for by Mr. Keeping, (Fossils of Upware) on the supposition that the purer carbonate of lime was uncongenial to the phosphate matter which was taken up more readily by the more argillaceous mud, which formed the impure limestones and which filled the cavities of the shells and produced the casts and moulds of which we have spoken.

The lesson to be learned from a careful study of the mode of occurrence of our phosphates, and of the conditions under which they have probably been accumulated, are obvious. We see that the formation of phosphatic deposits is not confined to any one geological period, but will follow whenever certain conditions, (some of which have been given above) are fulfilled. The association of phosphatic deposits with breaks or interruptions in the conformability of the strata, and the connection between the two, are also not without their practical bearings.

CALCAREOUS MARLS (NOT PHOSPHATIC) OF THE CRETACEOUS AND TERTIARY FORMATIONS.

For the sake of completeness we append here a short notice of certain calcareous marls, which have no unusually high percentage of phosphoric acid, but which can be advantageously used in agriculture where they are easily accessible.

Cretaceous marls.—In the upper part of the Eutaw formation, throughout the Rotten Limestone, and in the overlying Ripley, there are beds of calcareous matters which may be profitably used upon the fields where the cost of applying them is not too great. Most of these marls have been spoken of in connection with the phosphatic marls with which they are commonly associated, and there appears to be little need of adding to what has already been said.

Tertiary marls.—The principal horizon at which these materials occur are

(a). In the Nanafalia section of the Lignitic, already mentioned in connection with the phosphatic marl. This marl bed appear in the bluffs of the Tombigbee river at Nanafalia Landing in Marengo and thence for several miles down to Gay's Landing; on the Alabama it appears at Black's and Gullette's Bluffs and a short way up the river from the latter place. Between the two rivers this bed crosses Marengo and Wilcox counties and thence it may be followed eastward to the Chattahoochee river at Fort Gaines. This bed is prevalently a sandy bed with much greensand, loose shells, and occasional ledges with an excess of phosphate. It crops out at the foot of the Grampian Hills in many places. It is one of the most widely distributed and uniform of the marls beds of the state.

An analysis has been given (p. 55, No. 170), of a phosphatic ledge of this marl bed at Nanafalia, and I append here another analysis showing the general character of the tormation. No. 175 (p.64) was taken from the Nanafalia Bluff. Wherever this marl occurs its presence is easily recognized by the vigorous growth of the shrubs and herbs. Its fertilizing action is everywhere naturally demonstrated.

(b) The Wood's Bluff or Bashi marl has been mentioned incidentally above. This marl occurs in its typical exposure at Wood's Bluff on the Tombigbee river. It is seen at the base of the Buhrstone hills in Choctaw county, in the town of Butler, near Pushmataha and in other places. Between the rivers it is seen along Bashi creek, near Choctaw Corner, below Lower Peach Tree, and at the Alabama river at Johnson's Island. Across the Alabama it appears in the lime lands below Bell's landing, along the lower prong of Flat creek, whose soils are by it made exceptionally fertile, thence into Butler by Sepulga, and Georgiana, across the lower end of Crenshaw into Coffee, appearing at Kimmey's Mill below Elba. Thence it may be followed to the Chattahoochee river, which it reaches about Zornville. But east of Coffee county, superficial sands cover the older rocks to such an extent that their only exposures are to be seen in the ravines and in the banks of creeks, etc. This marl, like the preceding, contains a large percentage of greensand, as well as of decomposed shells, which furnish carbonate of lime in very available form, almost pulvurent. There is no simple marl in the state that is in better condition for use upon the fields than the Wood's Bluff marl.

Many years ago Prof. Toumey induced Mr. Kilpatrick, at Wood's Bluff, to use this marl upon his garden, and his sons have told me that the effects of its use were plainly discernible for many years. One need, however, only notice the vegetation along the line of outcrop of this marl bed to be assured that it is a good fertilizer. The lime hills just below Bell's Landing, and the lowlands of Flat creek in Monroe, may be cited in confirmation of this statement. I give on page 64 two analyses of this marl, No. 176, taken from near Butler, in Choctaw county; the other, No. 177, from "the caves" near Choctaw Corner in Clarke county. At this last named place, as well as at Wood's Bluff, the marl is most conveniently situated for digging, and there is no reason why it should not be extensively used.

(c) In the Claiborne section there is no lack of good shell marls.

At the Claiborne Bluff itself the main shell bed of 17 feet in thickness was originally a greensand bed, but where this bed lies exposed to the weather it becomes oxidized and assumes a red or yellowish color. This bed, though packed with shells, has the interstices filled in with sand, and thus the percentage of silica runs up pretty high. Its value as a fertilizer depends solely upon the carbonate of lime of the shells, which is usually in not so available condition as in the case of the Woods Bluff marl. Analysis No. 178 shows the composition of this bed at Claiborne. Below this stratum follow many feet of calcareous beds, some of which contain large amounts of lime and are suitable for use as marls. No. 179 shows the character of these beds at the Claiborne Bluff, and No. 180 their characters at the Coffeeville Landing on the Tombigbee. (Analysis on page 64.)

Where this bed outcrops in the piney woods of Clarke and Choctaw, it causes the formation of what are locally called "piney woods prairies," i. e., limy fertile spots in the piney woods, a testimonial to the fertilizing qualities of the marl. At no place is this marl more easy of access than at the Coffeeville Landing.

(d) The White Limestone, as its name implies, is a calcareous formation. The lower part of this formation has generally the composition of an indurated marl similar to the Rotten Limestone of the Cretaceous. In its disintegration it yields a soil similar to that of the latter. These soils characterize the Lime Hills of Clarke, Washington, Choctaw, Monroe, etc. No. 181 shows the composition of this rock as it occurs in the upper part of the Claiborne bluff in Monroe county.

The upper part of the White Limestone formation contains a large amount of a soft chalky limestone that could easily be pulverized and rendered fit for application to the fields which it would undoubtedly, in almost every case, greatly benefit. This formation crosses the entire state and underlies the whole peninsula of Florida. It is easily dug up and cut when fresh, and for this reason is much used in the construction of chimneys, underpinning for houses, etc. Its composition is fairly well shown in analysis No. 182 (page 64), of a specimen taken in Clarke county a short distance north of Jackson.

Table of Analyses of Marls and Greensands, (not highly phosphatic) from the Tertiary Formations of Alabama.

NAME AND LOCALITY.	Insol'ble Matter.	Carbon-ate of Lime	Potash.	Phos-phoric Acid.	ANALYST.
a. Nanafalia Section.					
175. Greensand marl, Nanafalia Land'g, Marengo county..	37.38	43.15	2.25	.04	H. M. Calley.
b. Wood's Bluff Section.					
176. Greensand shell marl, near Butler, Choctaw county...	67 84	24.74	1.03	.16	"
177. Greensand shell marl, Choctaw Corner, Clarke county	64.44	31.02	.46	.22	"
c. Claiborne Section.					
178. Shell marl, Claiborne Bluff, Monroe county..........	47.86	47 07	.33	.03	"
179. Greensand shell marl. Claiborne Bluff, Monroe county.	62.31	27.20	.63	.13	"
180. Greensand shell marl, Coffeeville Landing., Clarke co.	64.31	26 85	.37	.04	"
d. White Limestone Section.					
181. Soft white limestone, Claiborne Bluff, Monroe county.	31.31	62.42	.50	.09	"
182. Soft white limestone, near Jackson, Clarke county....	2.54	86.78	.35	31	T. W. Palmer.

ECONOMIC RELATIONS OF THE PHOSPHATES.

1. *General statement of the quality of the Alabama materials, their quantity, and recommendations as to mode of application.*

The commercial or agricultural value of the numerous varieties of marls existing in Alabama depends, 1st, upon their content of phosphoric acid, lime or potash; in other words, upon their fertilizing power; and 2d, upon their abundance and the cost of application to the soil; i. e., upon their availability.

The analyses already given will show the composition of many of our phosphatic marls, greensands, etc., as well as of the most important non-phosphatic calcareous marls.

From these analyses it will be seen that there are three grades of phosphatic materials found in the state, viz: *1st, Phosphatic nodules* and phosphatized shell casts, containing from 20 to 30 per cent. of phosphoric acid, and therefore to be compared with the high grade phosphates of South Carolina. *2d, Phosphatic greensands*, with very little carbonate of lime, averaging perhaps 4.5 per cent. of phosphoric acid, and with these might perhaps be classed the phosphatic siliceous limestone or calcareous sandstones which occur across the state in the latitude of Livingston, Prairie Bluff, Minter Station, etc. *3d, The greensands* containing only about 1.5 to 2 per cent. of phosphoric acid, but on the other hand, from 15 to 20 per cent of carbonate of lime in a loose pulverulent form.

We can probably best arrive at a conclusion as to the possible future value of these several grades of phosphates by considering each in turn.

a. The Nodules and other High Grade Materials.—Thse are too hard and insoluble to be used, except for the manufactures of superphosphate, unless ground to fine powder —"floats." They are equal to the Charleston phosphates in their percentage of phosphoric acid and in the absence of any large percentage of iron and alumina.

This upper bed has an average thickness of three feet, and it is known to extend from Coatopa in Sumter county, past Snow Hill in Wilcox, to near Bragg's Store in Lowndes. having essentially similar composition throughout this distance.

In regard to quantity therefore, these two beds are sufficiently large to be profitably worked.

2. *Comparison in Detail of the New Jersey phosphatic Marls, with those of Alabama.*

We have said above that the Greensands of Alabama have essentially the same composition as those of New Jersey, which are so highly prized and universally used in that state, and our assertion was based upon a comparison of the published analyses of the New Jersey marls with those recently made from Alabama materials. Not to go too much into details, I have here taken the mean of a great number of analyses of the Alabama greensands, and placed them in comparison with the average from analyses of the New Jersey marls. And since the experience of farmers has shown that the marls are valuable first of all, in propoition to the percentage of phosphoric acid which they contain, I have made the comparison on the basis of this ingredient, calling attention where needed, to the percentage of carbonate of lime, which experience has also shown to be a very valuable constituent of all the marls.

A. New Jersey Marls.

1. The average marl from the Lower bed (New Jersey) contains 1.14 per cent. phosphoric acid, which is not high, but the marl contains in addition, 10 to 20 per cent. of carbonate of lime, in fine powder. "In the neighborhood of the marls where it costs but little more than the cartage, a great deal is used which is much poorer than this, but there is no trouble in finding millions of tons of this quality. It is used in larger quantity than the other varieties, and is remarkable for the permanent improvement it makes in the soil." (Extract from Report of State Geologist of N. J.)

2. The average of five analyses given as representing the green marls of the Middle Bed, shows about 2 per cent. of phosphoric acid. Many hundred tons of this marl

are shipped every day over the railroads to the different parts of the state.

3. The average of four analyses given as representing the composition of marls of the Upper Bed, shows about 3 per cent. of phosphoric acid. This marl is also shipped by rail to all parts of the state.

These averages are considered by the State Department of Agriculture of New Jersey, as showing the general character of the three grades of marl in use in that state.

For the sake of comparison, I have taken the means of a number of analyses of typical samples of the various marls occurring in Alabama, showing the average percentage of that most important constituent, phosphoric acid.

B. Alabama Marls.

The Hamburg Greensand.

The line of outcrop of this belt across the state, near Pleasant Ridge, Eutaw, Marion, Hamburg, Selma, Mulberry, Prattville, and Wetumpka, has already been given.

The locality at Hamburg has been much more closely examined than any other in the state, and a great number of specimens from there have been analyzed.

The greensand proper is about five or six feet in thickness, but associated with it is a bed of about the same thickness, which holds phosphatic nodules, and which itself is highly phosphatic. We shall call this the Matrix of the nodules to distinguish it from the greensand.

(a). The Greensand. This varies very considerably in composition as may be seen from the analyses already given.

Excluding all the exceptionally high percentages, we find as the mean of eight analyses of the average typical greensand, 4.6 per cent. of phosphoric acid. The whole bed will in all probability sustain this average.

(b). The Matrix.—The analyses of eleven typical specimens give an average of 2.5 per cent. of the phosphoric acid.

Specimens from this bed have been collected and analyzed from Marion, Greensboro, Choctaw Bluff, Eutaw, Selma, Summerfield, and localities in Autauga and Elmore counties but no care was taken in selecting the sample, to separate the greensand from the matrix of the nodules, and the following analyses may be considered as representing the averages of the two combined.

The average of four analyses of specimens from Marion, show 2.9 per cent. of phosphoric acid; of three specimens from Eutaw to Greensboro, 4.2; of four specimens from between Selma and Summerfield, 4.46; of seven specimens from Autauga county between Mulberry and Prattville, 3.15; of three specimens from near Wetumpka, 1.15 of phosphoric acid. The average of these nineteen analyses, together with the twenty-one from Hamburg, forty in all, thus given as fairly showing the composition of this greensand at the different localities between Eutaw and Wetumpka, show 3.33 per cent. of phosphoric acid. and I am satisfied that the bed will sustain this average, or even show a higher percentage when a greater number of analyses is made.

The Livingston, Coatopa, Richmond, Fort Deposit Greensand.

This bed, as has already been said, comes to the surface in a belt approximately parallel to the preceding, but on the southern border of the prairie region. Associated with it are the phosphatized shell casts, and the siliceous phosphatic limestone which have been mentioned above.

The greensand has been examined at several points extending from Coatopa, in Sumter Co. to Snow Hill, in Wilcox Co., and it has pretty uniform characters through this whole distance. Its thickness is some four or five feet, and like one of the New Jersey marls above described, holds in addition to the phosphoric acid, about 30 per cent. of carbonate of lime in a fine earthy powder.

The average of eight analyses of this greensand from various localities from Coatopa to Snow Hill, shows 1.44 per cent. of phosphoric acid, and over 30 per cent. of soft pulverulent carbonate of lime. The close approximation in composition of this greensand to some of the New Jersey marls, which have been so successfully used, would be a good recommendation of itself, but we have fortunately a few field experiments which have tested its value in a practical way. (These experiments are described below.)

While this marl contains much less phosphoric acid than the marl of the Hamburg belt, it will doubtless prove an efficient fertilizer by reason of the carbonate of lime which it holds in addition to the phosphoric acid.

The Nanafalia Marl.

In addition to the two great marl beds above described, of the Cretaceous formation, attention has recently been called to others in the Tertiary formation to the southward.

The most important of these, and one of the most important in the whole State, is the Nanafalia Marl, which appears on the Tombigbee river at Nanafalia Landing, Eureka Landing, etc., and on the Alabama at Black's and Gullette's Bluffs, but which may easily be traced across Choctaw, Marengo and Wilcox counties into Butler, and thence to the Chattahoochee river. This is a greensand marl, rich in carbonate of lime, and having a very considerable thickness, in places thirty to fifty feet, but the main bed is from fifteen to twenty feet. Some of the indurated ledges which traverse this marl bed, hold as much as 6.7 per cent of phosphoric acid, but the average will fall much below this, so that it might perhaps not be classed with the phosphatic marls at all; still, the physical condition of the marl, and its high percent of carbonate of lime, will make it one of the most valuable natural fertilizers in the State.

The analyses made, show from 40 to 70 per cent. of carbonate of lime.

The Wood's Bluff or Bashi Marl.

This bed of greensand with high percentage of carbonate of lime, appears at Wood's Bluff on the Tombigbee river, and at Johnson's Wood Yard, just below Bell's Landing on the Alabama river, and in many places in the interior of Choctaw, Clarke and Monroe counties. It has comparatively little phosphoric acid, but a large amount of carbonate of lime, and is usually in most excellent condition physically, being almost pulverulent, especially where protected by the indurated portions of the bed. Some tests have been made of it as a fertilizer in Clarke county, and the results have been very satisfactory.

The St. Stephens' Marl.

Lastly, at St. Stephens on the Tombigbee river, and extending across Choctaw, Washington, Clarke and Monroe counties, there is a clayey marl which appears as the basis of the "Lime Hills" soils which exhibit an exceptional degree of fertility. I have not heard of this marl being used as a fertilizer, but there is no doubt of its value upon the light and sandy lands which are found always close to it.

3.—Can our Phosphatic Marls be Profitably Used?

We have seen above that our marl beds extend over a great area and contain each a quantity of available marl sufficient for all our needs for many generations to come. As regards their quality we have seen that they are very similar to the marls so extensively used in New Jersey.

The question that now most concerns us is whether or not these marls can be profitably used upon our soils. I think this question can be affirmatively answered. 1st. Upon general scientific principles. 2nd. By noting the results attained by the farmers of other States, notably New Jersey, by the use of marls quite similar in quality to ours. 3rd. By giving the experience of the few among the farmers of our own State who have used these very marls upon their fields for the past five or six years.

1st. Objection has been urged even by chemists, that so small percentage of phosphoric acid, and that too in the insoluble form, can be of comparatively little benefit to the growing crop. In answer to this objection it may be said that the experience of New Jersey farmers, and of our own too, so far as it goes, has demonstrated beyond all peradventure, that marls with this small percentage of phosphoric acid and in this insoluble form *do actually* prove of benefit to crops and *have actually* brought the New Jersey soils from the condition of barren sands up to a degree of fertility which is not equalled by the soils of any other State of the Union.

It seems to me that this should be conclusive, but as I have time and again published these facts, and there still remains doubt as to the value of our phosphatic marls, perhaps an attempt to show *how* it happens may not be out of place.

Commercial phosphates are, as a rule, applied to the soil in a soluble form but experiments by Thenard have shown that when given to the soil in this form the phosphoric acid very speedily, (after the lapse of a day or two at most) goes into insoluble combinations with the iron, alumina, lime, or magnesia of the soil, and since the plant contains a very small percentage either of iron or alumina or lime or magnesia, it is certain that the phosphoric acid is not assimilated from these insoluble compounds until they are decomposed, and this decomposition appears, for the most part to be effected through the agency of the alkaline salts present in the soil, and partly also, as shown by the experiments and observations of Liebig, Heiden, Knop, and others, through the solvent action of the acid excretions of the plant roots themselves. The experiments show that the phosphoric acid of commercial super-phosphates, after two or three days in contact with the soil, is in quite as insoluble a form as the phosphoric acid of our marls. If the plant is able to assimilate the phosphoric acid from the first, it is certainly possible for it to do so from the second.

In the notice of Alabama phosphates in the report on the Mineral Resources of the United States for 1886, Dr. Day writes as follows: "Since the announcement of the discovery of the phosphates in 1884, it is remarkable that very little has been done towards utilizing these deposits. The chief reason for this seems to be the reluctancy to invest capital in an industry which can only turn out a product to be consumed locally. These phosphates and marls are, however, extremely valuable and there is absolutely no reason why they should not be used in much larger quantities than in the prosperous state of New Jersey, where of marls alone at least 800,000 tons by no means so rich in phosphoric acid, are annually applied to the soil. The questionable opinion seems to be prevalent that only such fertilizers can be used to advantage, in which the phosphoric acid is in a soluble condition. It is true that for quick benefit, such fertilizers give most immediate returns, but the employment of ground bones shows the benefit which can be obtained from the use of fertilizers in which the phosphoric acid is insoluble. In the phosphate rock of Alabama, the percentage of phosphoric acid is lower than in ordinary commercial fertilizers, and it is less soluble, but still the poorest of these marls contains many times the phosphoric acid of an ordinary rich soil. Therefore the question of ultimate benefit is simply as to how many tons of marl or phosphate must be applied per acre, to add to the soil as much phosphoric acid as is contained in the quantity of commercial fertilizers ordinarily applied. A serious difficulty in selling the phosphates and marls is offered by the state laws, which rule out of the market the only mineral substance which this state possesses."

2nd. I am aware that with many, and very naturally too, an opinion based upon general considerations has very little weight, and I therefore present the following from the experience of the New Jersey farmers in the use of materials similar to our.

The greensands of New Jersey have essentially the same composition as ours, as has been shown at length in division 2 above, and here are some statements taken from a Report of the New Jersey Board of Agriculture, showing what a complete revolution the use of these marls has worked in that state. "The marl has been of incalculable value to the country in which it is found. It has raised it from the lowest stage of agricultural exhaustion to a high state of improvement. Found in places where no capital and but very little labor were needed to get it, the poorest have been able to avail themselves of its benefits. Lands, which in the old style of cultivation had to lie fallow, by the use of marl produce heavy crops of clover and grow rich while resting. Thousands of acres of land which had been worn out and left in common, are now, by the use of this fertilizer, yielding crops of the finest quality. Instances are pointed out everywhere in the marl district of farms which, in former times would not support a family, but are now making their owners rich from their productiveness. Bare sands, by the application of marl, are made to grow clover and then crops of corn, potatoes and when. What were supposed to be pine-barrens, by the use of marl, are made into fruitful lands. The price of land in this region was considerably below that in the northern part of the state forty years ago; now that the lands are improved, their prices are higher than those in the northern part of the state, though even there they are higher than anywhere else in the United States."

In the winter of 1876–7, a series of questions relating to the quantity of marl used per acre, the benefits resulting from this use, the mode of application, etc., was sent out to the farmers of New Jersey, and from the answers received, detailing the results of experience, together with the chemical analyses of the marls, the following conclusions were drawn:

"1st. That the most valuable marls and those which will pay best the cost of long transportation, are those which contain the highest percentage of phosphoric acid.

"2nd. That the most durable marls are those containing carbonate of lime, the more the better.

"3rd. That the potash in the marl has but very little, if any, present value, it being combined with silica, and so insoluble.

"4th. That greensands containing but little of either phosphoric acid or carbonate of lime, become active fertilizers when composted with quick lime.

"5th. That marls which are acid and burning from containing sulphate of iron, can be rendered mild in properties and useful as fertilizers by composting with lime.

"7th. That crops particularly improved by it are all forage crops—grass, clover, etc.; for these the green marl may be spread upon the surface to the amount of from one hundred to four hundred bushels per acre. The crop is generally doubled, and in some cases quadrupled, by this application. Other marls must be used in larger quantities, but will produce good results."

3rd. With this statement of the chemical and physical characters of our Alabama phosphatic marls, and with the record of the experience of New Jersey farmers in the use of similar marls, which to say the least are no better than ours, (and all the analyses show them to be if anything inferior) can any one doubt that our marls, if properly used, will be of inestimable benefit to our farmers?

But we are, fortunately, not obliged to go out of the state for data to show that our marls are of value.

Since their discovery in 1884, four farmers residing in different parts of the state, have been induced to make thorough tests of them, and since these tests have been made with all the varieties of phosphatic marl above mentioned, and upon every variety of soil and in four widely distant localities, I think they may be taken as giving absolute practical proof of what we may expect from the use of these marls.

The greensands of the Hamburg belt have been tried at Eutaw by Mr. T. J. Anderson, the Coatopa marl by Mr. John Wiatt at Coatopa, by Dr. G. W. Kyser at Richmond, Dallas county, and by Mr. W. S. Purifoy at Snow Hill, in Wilcox county, and the Nanafalia marls by Capt. W. H. Homer at Mobile.

Mr. Anderson writes, (1886): "Last year my son and myself experimented somewhat with the marl and with good results. You remember the old field near the bed of marl was poor and worn out. It took an average of five acres to the bale of cotton. On one acre we put nothing but the marl, pulverized as well as we could do it with a good corn and cob crusher. We used about three quarters of a ton on that acre, and no other fertilizer. The result was 1200 lbs. seed cotton. On another acre we used the same amount of marl and 30 bushels of crushed cotton seed; result about the same. On another acre we used marl, stable manure, and lot scrapings with about the same result. To the poorest spot (about three acres) we then applied the marl mixed with coal and pine wood ashes; result about 600 lbs. seed cotton to the acre. We noticed that the marl did best on clay land, and that where it was used alone and freely, the long dry spell did not show its effect much.

We planted some cotton in an old road, nothing but clay, using the marl freely, and the stalks never did shed the foliage until frost. We are perfectly satisfied with the results and intend to use the marl more extensively this year. We also used it on Irish potatoes with fine results both as to quantity and quality. Also tried it on the sweet potatoes, but the result was unsatisfactory, more vines than "taters."

I may remark in connection with this extract that the material used by Mr. Anderson is not the greensand proper, with its high per cent. of phosphoric acid, but has rather the composition of the matrix of the nodules, say 1 or 2 per cent. The Hamburg greensand itself has never, to my knowledge, been adequately tested.

Mr. John Wiatt of Coatopa, writes (1886): ", In reply to your enquiry I will say that my experiments with the marl have been very satisfactory. You will remember that when you were here last, you suggested that I make an experiment with the clay marl alone by spreading it broadcast upon the land. I did this last year, on half an acre, applying at the rate of eight tons to the acre. Adjoining this on the same quality of land I used compost, about the same quantity and with but little better result than from the marl alone. I think where nothing but the marl was used, the dry weather affected the land less than where the compost was used. I notice that the lands where the marl has been applied for the last three years in small quantities in compost, are changing very much in color, growing darker, and where formerly it baked badly, thus preventing a stand of cotton, it is now entirely changed, having become soft and mellow, and therefore more productive. The result from the ground rock is much more marked."

In addition to this report from Mr. Wiatt I may say that when I visited his place two years ago, there were several spots in his field conspicuous by the deep green color of the foliage of the cotton plants, and the greater height of the stalks, nearly twice that of the plants in the rest of the field. On enquiry I was told that these were the spots where he had first thrown the marl in piles from which it was afterwards distributed over the rest of the field. In spreading the marl, the rest of the land received a good deal less than was left on these spots. There could hardly be given a clearer indication that the marl had been too sparingly used over the rest of the field, for the marl had not been left long enough in these piles to have brought about any such result by the shading of the soil beneath. I am glad to say that Mr. Wiatt took the hint and more than doubled the quantity of marl upon his field the next year.

Mr. W. S. Purifoy, of Snow Hill, was one of the first to make use of the marl, which, fortunately, was found very convenient of access upon his land. He has experimented with it every year since 1884, and has published at my request, the results of these trials each year. At this time, 1886, he writes: "There is one result attending the use of the marl of which I have not yet made mention, and that is that it improves the physical condition of aluminous soils, rendering them more easily cultivated; the loose nature induced by their application favors the germination of the seed, thereby securing a stand more readily. This condition of the soil is also favorable to the growth of the crop, in that it permits access of the atmospheric air, and brings about the conditions necessary to reduce the elements of the fertilizer to the form in which they are best suited to be taken up by the plants. To bring about these physical conditions, is in my opinion, no less important than to supply the elements of plant food. I have been using these marls on my lands with satisfactory results each year since their discovery. I apply it in connection with cotton seed and stable manure. Lands that had been exhausted and given up to sedge and briars, are now producing paying crops. Experience has shown the economy of bringing up lands gradually; which fact has induced me to pursue such methods as will render the land perceptibly more productive for each succeeding crop. To this end I have increased the proportion of marl in my compost heaps relatively to the other ingredients. The proportions as now used are as follows: Marl, 1,500 lbs.; stable manure, 300 lbs.; cotton seed, 200 lbs.; making one ton, which I apply per acre. With the lights now before me, I shall follow this plan in the future."

Mr. Purifoy's experiments, extended over a number of years, go to show that while the plants grow off more rapidly when fertilized with superphosphates, they stand the later drouths better and produce finally as good crops when treated with the phosphatic greensands.

Quite similar to Mr. Purifoy's is the experience of Dr. Geo. W. Kyser, of Richmond, Dallas Co., also extending over a number of years. He has used as fertilizers not only the greensand marl, but also a ground up phosphatic rock occurring on his place. Dr. Kyser made some comparative tests which are of interest. The commercial phosphates caused the cotton plants experimented with to grow off much faster than the ground rock and greensand, but on the other hand, those plants fertilized with the rock and greensand stood the drought much better and were green and flourishing at least three weeks after those treated with the commercial fertilizer had turned red and ceased making.

I have no report direct from Capt. Homer, but Mr. D. W. Langdon, Jr., informs me that he has for some years been using the Nanafalia marl, with great profit to himself, upon his market gardens in Mobile.

4. Limitations to the use of the marls depending upon their cost.

Even where a marl is known to exert a good effect upon the growing crop, the cost of getting it up and applying to the lands, might easily be greater than the benefits resulting from its use, and this is particularly likely to be the case where the marl is at a distance from the crop, and has to be transported by rail or wagon. There is in all these marls a very considerable percentage of inert matter, which very materially increases the cost of transportation.

We may make a rough approximation of the value of the phosphatic marls by assuming that the phosphoric acid is the only effective ingredient, and basing our calculations upon that assumption; if in addition, the marls contain a notable quantity of carbonate of lime, so much the better.

Available phosphoric acid is estimated now to be worth about 7.5 cents a pound, and we shall certainly be on the safe side if we put the value of the phosphoric acid of our marls at 5 cents a pound. With this valuation a marl with 1 per cent. of phosphoric acid would contain 20 lbs. to the ton, and be worth $1.00 a ton. A marl containing 2 per cent. would be worth $2.00, and so on.

With these data it might be easily calculated whether or not it would pay to apply a marl to the land. It would obviously not pay to transport any of the Alabama marls long distances by rail, with the present high rates of freight; but if experience should show that these marls were better than many of the commercial phosphates, the freight rates would certainly be reduced when the amount of traffic would justify it.

In looking over the Reports of the New Jersey farmers upon the cost of the marls in that state, we find that it varies from 40 or 50 cents a ton in the immediate vicinity of the pits, to $2.50 where it has to be hauled, say 10 miles. The farmers find that it pays even at the last named price, including all the cost of transportation, spreading, etc.

As to the value of the greensands as compared with stable manure, the New Jersey farmers vary in their experience. Some consider it equal to the barn-yard manure, load for load; some consider it better for certain crops, especially for grass; while others think one load of barn-yard manure equal to two, or even in a few cases, to three of the greensand.

We shall certainly not be overestimating its value when we consider our greensand to be worth about half as much per ton or load, as stable manure, and upon this assumption it will be easy for any person to determine for himself, whether or not it will be profitable for him to use greensand. All the above estimates refer to the immediate results to be gotten from the use of marls, but it should be borne in mind that the phosphatic greensands produce a lasting improvement of the lands upon which they are used, and the good effects of their use can often be seen for years after they have been applied to the soil. This should have some weight in estimating their value.

In the application of our marls, I do not think we can do better than to follow the practice of the New Jersey farmers, who use their marl either alone, spreading it upon the land in the fall and winter months, in quantity varying from 10 to 50 tons per acre, the more the better. In this form it answers well for clover, grass and other forage plants. Or they compost it with equal parts of stable manure, or with stable manure and quicklime, in which form it is a good fertilizer for all crops without exception.

It is sometimes urged as an objection to the use of the marls that our farmers need quick results and cannot afford to build up their lands for the benefit of posterity alone.

That this objection is absolutely without weight has been conclusively shown by the experiments of Mr. Purifoy, in which it was seen that while the crops fertilized with acid phosphate grow off a little more promptly *at the beginning* of the season, those upon which the marl was used in proper quantity quite equalled the first *by the end* of the season, so that even upon the first crop the marl proves of as much benefit as the commercial fertilizer, and there can be no comparison between the two as regards the permanent improvement of the soil.

These farmers throughout the state upon whose lands these marls occur, could not possibly be losers by giving the marls a thorough test in the field, on the contrary they could hardly fail to be gainers thereby. It is to them that we must look for the introduction of the marls into the agricultural practice of Alabama.

GEOLOGICAL SURVEY

OF

ALABAMA.

EUGENE ALLEN SMITH, PH. D., STATE GEOLOGIST.

BULLETIN No. 3.

A PRELIMINARY REPORT ON A PART OF

THE LOWER GOLD BELT OF ALABAMA,

in the Counties of Chilton, Coosa and Tallapoosa.

BY
WILLIAM B. PHILLIPS, PH D.
Prof. of Chemistry and Metallurgy, University of Alabama
and
CHEMIST TO THE SURVEY.

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To His Excellency,

THOMAS. G. JONES,

Governor of Alabama:

DEAR SIR:—I have the honor to transmit herewith Bulletin No. 3 of the Geological Survey, a Preliminary Report on Part of the Gold Region of Alabama, by Dr. William B. Phillips.

Very respectfully,

EUGENE A. SMITH,
State Geologist.

University of Alabama, May 1, 1892.

UNIVERSITY OF ALABAMA,
February 20th, 1892.

DR. EUGENE A. SMITH,
State Geologist:

DEAR SIR:—I beg herewith to submit a Preliminary Report on a part of the Lower Alabama Gold Field in the counties of Chilton, Coosa and Tallapoosa, prepared during the summer of 1891.

Very respectfully,

WILLIAM B. PHILLIPS.

PREFACE.

Specific interest in the Lower Appalachian Gold Field dates from June, 1540, when, according to Pickett's History of Alabama, Vol. I, pp. 10 to 15, Villabos and Silvera, two cavaliers from De Soto's army, (then encamped at Chiaha, the site of Rome, Georgia,) went with an Indian guide in search of gold. "About this time a principal Indian from Costa, a town below, informed De Soto that in the mountains to the north, at a place called Chisca, were mines of copper, and of a yellow metal, still finer and softer. Having seen, upon the Savannah, copper hatchets supposed to be mixed with gold, his attention was deeply aroused upon the subject. Villabos and Silvera, two fearless soldiers, volunteered to explore that region. Furnished with guides by the chief of Chiaha they departed upon their perilous journey." . . . . . They seem to have been gone some time for they returned in July. "Three days after this, Villabos and Silvera returned from Chisca. They passed into the mountains, found no gold, but a country abounding with lofty hills and stupendous rocks. Dispirited, they returned to a poor town, where the inhabitants gave them a buffalo robe, which they supposed once covered a tremendous animal, partaking of the qualities of the ox and the sheep. According to Garcelasso, the mines which they reached were of a highly colored copper, and were doubtless situated in the territory of the county of DeKalb."

This is the earliest prospecting trip for gold into the Appalachian Mountains of which I can find mention, and, like a great many subsequent trips of the same nature, resulted in the finding of "a country abounding with lofty hills and stupendous rock," but devoid of gold.

De Soto, while wandering in a somewhat aimless manner about the States of Georgia, Alabama and Mississippi, dining (when he could) on dogs which were said to be as toothsome as a fat wether, had his ears open for any report of gold or silver. He does not appear to have found any gold and all the silver obtained was secured *vi et armis* from the hapless Indians. Pickett says (ut supra, p. 91)

"The Creeks wore many ornaments of silver. Crescents or gorgets, very massive, suspended around the neck by ribbons, reposed upon the breast, while the arms, fingers, hats, and even sometimes the necks, had silver bands around them." This was in 1777, and it is not stated whether or no they had such ornaments in 1540. It is not likely that such was the case. I have in my possession now a silver crescent and a pair of silver bracelets obtained from some Indian graves in Coosa county, but they are evidently of foreign origin, probably English.

Of the thousand and one rumors of Indian silver mines along the Appalachian Range, from Winchester to Wetumpka, it is not likely that a single one is true. I have visited many localities from which the Indians were said to have extracted silver and have assayed samples of the so-called ore without finding more than the merest trace of gold or silver. What the pre-historic inhabitants might have done is irrelevant to the question; they did mine mica in North Carolina and Alabama and they did mine and treat copper ores. And the Indian, such as roamed these forests 150 years ago, mined and sold kaolin, exporting it from Jamestown. But I have found no evidence that the Indian of 1540 or of any other date, mined and treated either gold or silver ores. Nuggets of gold, picked up in some branch, are no proof of the mining of ore or the treatment of it when mined. De Soto's "copper hatchets, supposed to be mixed with gold" are illustrations of a great many other suppositions, equally baseless concerning the occurrence and distribution of the precious metals.

I have been unable to ascertain when gold was first discovered in Alabama, probably the year 1830 will approximate the true date. At any rate we know that shortly afterwards the placer or gravel washings became the seats of an active industry in the counties of Cleburne, Talladega, Randolph, Tallapoosa, Coosa, Chilton and, perhaps, also in Clay. But of the yield of gold there is no record, or indeed of anything in connection with the matter, except that at such and such localities large numbers of men were engaged in the work and that at certain places it was said to be profitable.

No report on the subject has ever been issued by the State and, with the exception of the scattered remarks in Tuomey's Report of 1858, no notice has been taken of what I sincerely believe could be developed into one of the most successful enterprises in the State-gold mining. The present Geological Survey has acted wisely in devoting its attention mainly to coal and iron, for, with the meagre support afforded to it, little could be done by distributing the money over the entire State.

It is too small a piece of butter to be spread over a great deal of bread. The last Legislature, however, added to the means at the disposal of the survey and the first thought of the Director was towards the metamorphic region of the eastern part of the State, comprised within the limits already given and including about 3500 square miles.*

For convenience of reference it was decided to divide the gold fields into an Upper and Lower Field by a line running due east and west along the northern boundary of Chilton, Coosa, Tallapoosa and Chambers. To that part of the Field lying south of this line the name "Lower Alabama Gold Belt" was given, and it thus comprises the counties of Coosa, Tallapoosa and Chambers and part of Chilton and contains about 1700 square miles. To that part of the Field lying north of this line the name "Upper Alabama Gold Belt" was given. It thus comprises the counties of Cleburne, Clay and Randolph and part of Talladega, and contains about 1800 square miles. It was further decided to spend three months in each Belt. The work on the Lower Belt was progressing very well when I received word that my wife was very ill at home. This necessitated my presence there and I suspended the examination about the middle of August, 1891, after one months work, and was unable to resume it during the remainder of the year. This report is therefore incomplete even as regards the Lower Belt and is to be considered merely as a preliminary report. It was thought best to publish it in its present shape instead of waiting another year for its completion and to incorporate some additional information concerning this Belt with the report on the Upper Belt, to be published in 1893, if not sooner.

Some photographs of very interesting localities in Chilton and Coosa counties were taken, but, most unfortunately, the box containing the plates was broken in transit and the plates were lost. They represented views at the Rippatoe Mine, Alum Bluff and the neighborhood of Higgins Ferry across the Coosa River.

It is hoped to embellish the next report with numerous photographs of the principal gold bearing localities of both belts, and especially of Hog Mt, the Ulrich and Jones Pits, Silver Hill, Gregory

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*The total area of the crystalline rocks is 4425 sq. miles. E. A. Smith, Agric. Rep. 1881-2.

Hill, Blue Hill, the Devil's Backbone and other places belonging to the Lower Belt.

I desire to express my thanks to Prof. John M. Francis, of the University of Alabama, for much valuable assistance in the assaying of the samples; to Mr. E. E. Newton, a recent graduate of the Scientific Department of the University for aid in the field as volunteer assistant; to Major Jno. L. Harrell for the pleasure and profit of his company through many parts of Chilton county; and to Col. B. L. Dean for many kindnesses in Tallapoosa county.

WILLIAM B. PHILLIPS.

THE GOLD FIELDS OF ALABAMA.

General Description.

The Gold Fields of Alabama extend in part or wholly over the counties of Cleburne, Talladega, Randolph, Clay, Tallapoosa, Chambers, Coosa, Elmore and Chilton. The occurrence of the Gold is therefore confined to that portion of the State in which extensive areas of the crystalline rocks appear. It is not the purpose of this report to consider whether these rocks belong to the Archæan or to the Lower Silurian, whether they are orignal primitive rocks or the products of a more or less complete metamorphism. Probably the western edge of the Field is of Silurian Age, but it seems to me that the inner portion and especially the Eastern part are of older date. One might go so far as to say that if the rocks in the central and western part of North Carolina, and in the Northwestern parts of South Carolina and Georgia are of Archæan Age, then these rocks are, for there is the closest relationship between them, both from a stratigraphic and petrographic point of view. The Gold bearing rocks of Alabama are of the same age as the gold bearing rocks of North Carolina, South Carolina and Georgia, whatever this may be. The occurrence of large deposits of graphite might lead one to classify them as of a period when there was at least plant life on the earth, but, on the contrary the entire absence of fossils and other evidences of life, if we except graphite, would incline one to project their age beyond that of the Silurian. A long and careful examination of the district with especial reference to the stratigraphical relations of these rocks towards the Silurian rocks of the western edge and towards each other would have to precede a positive opinion.

The productive portion of the field is comprised within the following limits: From Calera, on the Louisville and Nashville Railway, thirty miles south of Birmingham, draw a line in a north easterly direction to Tallapoosa, Georgia, on the Georgia Pacific Railway. From the same point draw a line in a south easterly direction to Columbus, Georgia. We have thus, roughly speaking, an equilateral triangle of ninety miles on the side and the area will be about 3,500 square miles. I have used the expression "productive area" to imply that portion of the State in which gold mining has at some time or other been carried on with success. It is not to be taken as meaning that gold mining is now prosecuted within this area on an extensive scale, for such is not the case.

Within this area of 3,500 square miles the metamorphic and primitive rocks find their greatest development and form the south western termination of the great Alleghany Range, or, as it should perhaps be termed, the Appalachian Range.

The country rocks are for the most part crystalline schists and slates, talcose, micaceous, and graphitic, deeply buried on the south western edge beneath the clays of the Tuscaloosa Formation (Cretaceous) but outcropping with ever increasing boldness towards the east until in Coosa county, and farther east they appear with a very coarse granite in considerable hills and bluffs. The first appearance of the granite is in Coosa county near the town of Rockford; from this point to the east it occurs with marked frequency interstratified with graphitic schists and slates and imparting to the landscape quite a bold and rugged appearance.

CHILTON COUNTY.

HONEYCUTT'S MILL.

The most westerly exposure of the crystalline schists which I was able to observe is near Honeycutt's Mill in the western part of Chilton county, Sec. 17, T. 22, R. 13, E, 13 miles from Clanton, on Mulberry creek. At this place the creek has cut its way down through the overlying clays of the Tuscaloosa Formation and the underlying rock is well exposed. It is a greenish and bluish green slate, in places quite hard and crystalline. It strikes in a general north east course (N. 75E. near the mill) and dips 15 to 20 degrees south east. The bed of the creek is 125 feet below the general level of the country. In places the slate is soft and rotten, breaks down readily and gives a stiff reddish soil.* It frequently carries small veins of quartz, from one-half an inch to eight inches in thickness running parallel to the slate: It would appear that many of these quartz seams formerly carried pyrite, for there are evident traces of this mineral still to be found, with now and then a fairly good piece but partially decomposed. As a rule, however, the pyrite has disappeared, the quartz is cellular and, for the most part, barren, showing neither gold nor pyrite. It is noticeable that wherever the slate carries quartz it is harder and more crystalline than when the quartz is absent.

Placer mining has been carried on along this creek in a very small way for the last fifty years, beginning about two miles below the mill and extending about eight miles up the creek.

Along the little branches that make into the creek I panned thirty pans, finding gold in twenty-five and failing to find it in five. The gold is held in a mottled red and white clay, sandy and carrying angular fragments of quartz. This clay is underlaid by a stiff white clay devoid of gold. It is exposed in the bottom of the branches and is overlaid by from 4 to 6 feet of soil and reddish clay, free of gold. In every pan there was left at the last a heavy black sand, sprinkled with minute fragments of garnets and clear quartz. The thickness of the gold bearing stratum is from one to two feet.

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*Limonite (brown iron ore) occurs on the waters of Mulberry creek above Honeycutt's, in considerable masses.

The origin of the gold here is to be sought in the thin seams of quartz (formerly pyritous) between the layers of slate. The gold content of the pyritous quartz has been distributed in the clays resulting from the decomposition of the slates.

I remark here

1. No gold has been found in the soft slates which are free of gravel.

2. The quartz seams themselves show free gold in the pan now and then.

3. The clays resulting from the decomposition of the slates are of two sorts, a soft smooth clay with no gravel and no gold, and a sandy, gravelly clay with many angular pieces of quartz and half decomposed pyrite, carrying free gold.

4. The unfailing association of the gold with black iron sand and quartz, with occasional fragments of pyrite, points to the pyritous quartz seams as the origin of the gold.

Although gold is to be found in nearly every little branch running into Mulberry Creek, in the vicinity of Honeycutt's mill, yet I do not think that it occurs in sufficient quantities to warrant any further investigation. The gravel in which it is found is not continuous nor is it rich enough at any place that was examined for it, to be considered more than an interesting distribution of the metal. This is the most western point at which gold has been found in situ, and its association with quartz and pyrite is but another proof of the close companionship of these minerals in the Southern gold fields.

Between Honeycutt's Mill and Clanton I observed no exposure of the underlying rocks; they are doubtless overlaid by the Tuscaloosa clays which extend in an unbroken sheet across the State from Tuscaloosa to the south-east, obscuring the crystalline rocks entirely except where some stream has cut its way through.

On the west side of the Louisville and Nashville Railway the crystalline rocks are but seldom seen, as I went carefully over that part of Chilton County almost to the Autauga line without seeing any sign of them at all. None of the wells dug in that part of the county have penetrated to the old rocks, although some of them have been sunk through forty and fifty feet of soil and clay. The Tuscaloosa clays must be more than one hundred feet in thickness in this part of the State, in certain localities doubtless nearer two hundred feet than one hundred. No gold is to be found in that part of Chilton County below Clanton and on the west of the L. & N. R'y, which demands a more detailed examination. Near Verbena, a station on the Railway below Clanton, some prospecting for gold was carried on many years ago, but no evidence could be found that it was profitable or even encouraging. Some isolated placer washings may still be heard of but I do not think that we need pause to consider them. This part of the county is not to be regarded as a gold district, for, it is not until we reach the old Rippatoe Mines near the Coosa River that we come upon any sound basis for even a preliminary testing.

About one-half a mile north from Verbena, at the old Floyd Mill, there is a fine out crop of micaceous hornblende schist, tough and well crystallized. It strikes N. 50° E. and dips 15 degrees S. E. It is found also on the west side of the L. and N. R'y one mile S. W. of Verbena and there disappears beneath the clays.

WILLIAM HOWARD'S.

In the S. W. ¼ of Sec. 29, T. 21, R. 16 E., Chilton County, at Wm. Howard's, there is a good exposure of quartz interstratified with clay slate. It is of the sugary variety, very white and granular. A sample taken from a vein of eight inches thickness at Howard's gate gave in gold $6.20. A vein of similar appearance, however, at Tom Howard's in Sec. 29, T. 21, R. 16 E., gave only $2.06 per ton.

ROCKY CREEK.

On Rocky Creek, in Sec. 30, T. 21, R. 16 E., Chilton county, two miles east of Verbena, extensive washings for gold have been carried on in the gravel. Heavy ledges of a dark, fine grained hornblende schist, carrying biotite, cross the creek, bearing N. 15° E. and dipping 20 degrees to the S. E. These schists enclose bands of quartz, in places somewhat pyritous, which are rarely of greater thickness than a few inches. In the immediate vicinity of the quartz seams the schists are harder and more crystalline. The gold gravel underlies the soil at depths varying from 3 to 6 feet and extends on both sides of the creek for about one hundred yards. It is rarely more than twelve inches in thickness and is composed of rounded peices of reddish quartz from one-half inch diameter to six inches. The pay gravel lies on a greenish clay slate. Rocky Creek runs in a general N. E. course and the quartz seems bear in the same direction. The shifting of the creek bed from side to side has doubtless distributed the gold gravel over the area mentioned.

William Howard, an experienced gravel washer of the vicinity, told me that in about ten weeks he himself had obtained $200 worth of gold along Rocky Creek; in one day securing $19, The only apparatus used was the pick and pan. This was twenty years ago. Per contra, he says that a few years ago a stray miner worked there two months and got only $60.

Rocky Creek would not afford sufficient water for extensive operations, and, besides the pay gravel appears to have been pretty well worked over. A considerable amount of work has been done along the Creek from first to last, but none within the last twenty years. Most of the work was done before 1860, when through this part of the State there was much interest shown in gold mines and especially in placer mines. I saw no evidence of the existence of a workable seam of quartz on Rocky Creek near the old workings. At Howard's there is a better prospect for quartz mining than on Rocky Creek, for the existence of gold bearing sugary quartz at Wm. Howard's is an encouraging sign. It does not seem to me that Rocky Creek will afford pay gravel in sufficient amount and of sufficient richness to warrant any extensive investigations. Doubtless a considerable amount of gold was obtained along the creek fifty years ago with the simple appliances then in use, such as the pan, cradle, and Long Tom. The best of it has, however, been thoroughly worked so that it is now difficult to find a place from which good panning can be had.

THE RIPPATOE MINE.

This famous property is situated in Sec. 17, T. 21, R. 16 E., Chilton County. It was extensively worked prior to 1860, work having been begun here as early as 1835 and continued with but little interruption for twenty-five years. By far the greater amount of placer mining carried on west of the Coosa River has been done at this place.

The gravel lies on both sides of Blue Creek and is of the same nature as the Rocky Creek gravel. For a mile up the creek from Jas. Mims's, on both sides, there are innumerable old pits, trenches and ditches. These are now so fallen in that I had to sink two new pits in order to examine the gravel at all. Following is a vertieal section of a pit in the bottom of which we came upon a layer of auriferous gravel, very poor but of the same character as the richer gravel, as I was informed by Wm. Howard:

Vertical Section to Gravel, Rippatoe Mines.

Soil and Sandy Clay, 2 ft.	9 ft.
Soft reddish clay, inclining to bluish green at bottom, 3 ft.	
Stiff, bluish clay, a sort of pipe clay, 3 ft.	
Gold gravel, 1 foot.	

The gravel is imbedded in a reddish clay, at times somewhat indurated, but generally of a loosely compacted nature, yielding readily to the pick and shovel. From Wm. Howard and others who worked at these diggings I ascertained that the gravel was generally not less than six feet beneath the surface, varying from this depth to eight and even nine feet. As the deposit neared the adjacent hills the gold became scarcer and the gravel thinner and at greater depth.

A great deal of the gold obtained was found in the run of the creek, caught against upturned edges of the slate. Several pieces of gold valued at $1, $5, one valued at $20 and one at $70 were found at these diggings. It is impossible at this time to give any reliable estimate of the amount of gold obtained at the Rippatoe. An approximate statement could be given if it were known what the average yield of gold per bushel of gravel was, for it could be calculated how much gravel was removed. But there are no statistics and no reliable sources of information. The property was not worked by a regularly organized company, the different gangs of men were associated together for the more economical treatment of the gravel, they kept no permanent accounts, disbanding when they pleased and each going its own way without regard to the others. From first to last, however, there must have been a large amount of gold removed. The extent of the old workings proves that, for in those days when the miners did not find pay gravel they quit and went to some other place. It was not the custom to spend either time or money in prospecting on such an elaborate scale. There was enough water in the creek for their purposes, although not enough for a large business, and they kept at work in a small way for many years, accomplishing in the twenty-five years an astonishing amount. When the California gold fever came upon the country most of these miners were attacked by it and started for that Eldorado forthwith, and there has been no gold washing in this vicinity worthy of mention since 1855.

Only one placer mining company is now at work in the State, the Arbacoochee, in Cleburne Co. I have not visited the place, but understand that of late a better gravel has been found and that the operators are hopeful of good profits. Cleburne County belongs to the Upper Gold Belt and I have not yet visited that part of the State, and can not therefore speak of my own personal observation. But so far as concerns the old placer mines of the Lower Belt, lower Chilton, Coosa and Tallapoosa Counties, I do not think that any revival of the industry is likely to take place. The best gravel has been worked over as with a comb and nothing remains now that would attract capital, for it requires a large amount of money to operate such washings on a profitable scale.

At the Rippatoe the gold was derived from the small quartz veins lying between and in micaceous hornblende schists and clay slates. The creek has cut its way down through the schists and slates, undermining the quartz seams and distributing the resulting gravel along its course. The average width of the valley along which the gravel is found is less than two hundred yards, in linear extent three quarters of a mile. The relation of the gold gravel to the country rocks appears to be as follows:

The schists themselves are pyritous and also enclose small seams of pyritous quartz. They lie to the Eastward of the clay slates. The slates are softer and more easily broken down by atmospheric agencies and by running water. The schists, overlying the slates, are in this way undermined and finally give down more or less, and allow their quartz seams to be distributed as gravel along the bed of the creek. This result is accelerated by the occurrence of thin seams of pyrite between the quartz and the schists. In places the schists are so impregnated with pyrite that it can be seen plainly with the naked eye. In other places they present the appearance of a true gossan. On panning there is always left in the pan a mixture of black iron sand with small fragments of clear quartz, garnets and pyrite more or less decomposed.

The tendency of the clay slates in this part of the county to present the appearance of a gossan is shown on quite a large scale on the road from Verbena to Higgins' Ferry about one and one-quarter miles from the Rippatoe Mines. At this place a large seam of brown iron ore crosses the road and can be traced for several miles in a N. E. and S. W. direction. Some samples of the ore are very good and the outcrop is bold. There may be enough of this ore above water level to justify a development shaft or drift; it would appear that is is derived from the infiltration of ferruginous waters obtaining their iron from the oxidation of pyrite. I observed numerous cavities of pyrite crystals in the accompanying quartz. Several years ago the Sloss Iron and Steel Co. of Birmingham opened a deposit of this ore lying four miles north of this place, but abandoned the undertaking after going to considerable expense in the construction of a branch road from the L. and N. Ry. It may be, however, that the lower part of the deposit near Rippatoe is of better quality and in greater quantity.

On the land of James Mims in Sec. 16 is to be seen the same kind of gravel accompanied by the same ferruginous slates as appear on the Rippatoe property. Here also the gold gravel has been thoroughly worked over, and although a considerable amount of gold was obtained prior to 1860, nothing of consequence has been done since. I sampled a small seam of sugary quartz on the Rippatoe place near Tiernan's house below James Mims' and found it to contain, in gold, $2.06 per ton. The gravel washings at the Rippatoe have been practically exhausted, but it is probable that by careful investigation workable quartz could be found. The owners of the land should have it examined with this purpose, and I would recommend that they examine especially the western part of the property towards the upper waters of Blue Creek, for as one approaches the Coosa River the schists become much coarser and the dip rises. I observed neither gneiss nor granite on the west side of Coosa River in this part of Chilton County, but it is quite noticeable that the granitic and gneissic soils begin to appear in Sec. 15, T. 22, R. 16 E. In this section also on the land of Jackson Mims numerous pieces of magnetic iron ore have been picked up on the surface. Mr. Mims has prospected for the vein with drift and shaft, but has not yet come upon it. The magnetite is associated with a coarse hornblende schist carrying mica and garnets. No gold has been found in connection with it, nor in fact has gold been found on Blue Creek below the Rippatoe place.

Between the Rippatoe and Higgins' Ferry, about one half mile from the ferry gate, there crosses the road a seam of iron ore partly limonitic and partly of higher oxidation. It appears to have been derived from the oxidation of pyrite and the infiltration of iron-holding waters. The remains of pyrite crystals are to be seen in the associated quartz. The seam can be traced for a quarter of a mile, but does not show any reliable indication of increased richness. A similar ore is to be found in Coosa County also as in Sec. 31, T. 23, R. 20 E. and in Sec. 1, T. 22, R. 19, and in Sec. 6, T. 23, R. 1º, where it is partly converted into magnetite.

It is not likely that extensive deposits of good ore will be found where the evidences of the recent oxidation of pyrite are so numerous and so unmistakable. The limonites of S. E. Chilton and the middle and Southern Coosa are comparatively of recent origin. The rocks in which they occur are clay slates and micaceous graphitic schists more or less impregnated with pyrite. The rocks themselves may be, and doubtless are, of the Archaean Age, but the iron ore is of far more recent production, resulting, as it has, from the atmospheric decomposition of pre-existing beds and stringers of sulphuret of iron. Where the original amount of pyrite was very great or where local causes have led to a concentration of the iron these secondary ores are of value, but I can not speak hopefully of these ores. They do not seem to me to exist in sufficient quantity for commercial purposes.

COOSA COUNTY.

ALUM BLUFF.

The name Alum Bluff is given to a bold mass of micaceous schist and quartz rising to the height of 250 feet above Hatchet Creek, near its mouth, in Sec. 35, T. 22, R. 16 E., Coosa county. The schists are in places impregnated with the sulphates of iron and aluminum arising from the action of the sulphuric acid derived from the oxidation of pyrite. The so-called Alum forms a white incrustation on the surface of the bluff, and after a long drouth can be scraped up by the handful. It occurs most plentifully near the top of the bluff opposite a large pine tree standing some 200 feet above the creek. At this place there appears a heavy seam of bluish crystalline quartz carrying decomposed pyrite. It is eight feet in width, strikes N. 30 deg. E. and dips also with the schist S. E. 40 degrees. A sample gave to Lagerfelt and Mills, Birmingham, Gold 0.60 ounce per ton, silver, trace and was therefore worth $15.40 per ton. A sample of the walling next the quartz gave in gold, 0.35 ounce and silver 0.10 ounce per ton and was therefore worth $7.33 per ton.

The quartz is somewhat cellular and the sulphurets for the most part pretty well decomposed. This is probably a true vein and is well worth further examination. I did not observe it elsewhere in the immediate vicinity, as it lies in such a position as to be easily covered by the decomposing schists. The seam could be easily mined, as it stands well above Hatchet Creek and the upper two hundred feet of workings would be self draining. I was unable to ascertain the owner of the property, although I made diligent inquiry of well informed persons.

GOLD MINE RIDGE.

Secs. 1 and 2, T. 21, R. 16 E., Coosa Co.

Van Zandt and Smith prospected for copper and gold on this ridge in 1855, and Col. George and Jas. L. Tait for copper and graphite in 1872 and 1873.

The ore is quartz held in a micaceous schist and carries graphite and pyrite. I secured a sample from a four foot seam and it gave to Lagerfelt and Mills, gold 0.15 ounce and silver 0.25 ounce per ton and was therefore worth $3.35 per ton. A considerable amount of work has been done here, but all of the old pits, trenches, &c., have fallen in and nothing can be seen of the seam underground. I saw no evidences of the existence of copper in paying quantities, and the ore is too poor in gold to work for this metal under present conditions.

FLINT HILL.

Sec. 17, T. 22, R. 16 E., Coosa Co.

Heavy seams of crystalline quartz occur here in talcose schist. Of four samples taken only one showed more than a trace of gold and this one contained $4.13 per ton.

Flint Hill is about two miles above Wm. Hardy's Mill on Weoguffka Creek. At the foot of the hill coming towards Hardy's Mill there is found a heavy ledge of talco-micaceous schist carrying graphite and pyrite. These two minerals are so closely associated in the same rock as to give it a very odd appearance. Upon fire assay, however, I found no more than a trace of gold and silver.

In this part of the county many people have sought for a valuable silver mine said to have been worked by the Indians, but concealed by them, so that no one can find it. According to current opinion, the mine is extremely rich, having furnished the Indians with untold wealth for generations. When they left the county, some sixty years ago, they sealed up the entrance to the mine with heavy rocks and then obliterated all traces of the approaches to it. This was very unkind, for they had no reasonable expectation of returning to Coosa County, and could just as well as not have told where the mine was and how they obtained the ore. I am inclined to think that if the Indians mined silver in this part of Coosa County they had first to convey the ore there from some other locality, an operation by no means unheard of, it is true, but in this case hard to believe.

I have to thank Mr. R. C. Hardy, Dollar P. O., for many courtesies, especially in pointing out to me one of the late Wm. Gessner's Tin Mines. This is situated in the S. W. Sec. 24, T. 22, R. 16 E. Some excavations have been made here, and Mr. Hardy informed me that from the ore obtained Gessner got 3.50 per cent of tin. Mr. Hardy said that he was with Mr. Gessner when he took the samples and he gave me a piece of the ore from which it is said 3.50 per cent of tin was obtained.

The ore is a close grained, much distorted quartz veinlets bound in hydro-mica talcoid schist. No extensive investigation has been made at this place.

During my stay in this part of Coosa County I was the recipient of many kindnesses from Mr. Frank Higgins, who owns the Higgins Ferry and a great deal of the best land along the river contiguous to the Ferry. I desire to express here my obligations to him and the various members of his family. It is always a pleasure to meet wide awake, intelligent men who are interested in the development of the country.

The photograps taken in Chilton County and in this part of Coosa County were unfortunately lost in shipment to Tuscaloosa, so that no views can be given of the Rippatoe or the Alum Bluff.

ROCKFORD.

Between Higgins' Ferry and Rockford, the county seat of Coosa County, one sees the same schists and slates as occur on the west stde of Coosa River, but the dip is steeper and the texture coarser. About two and a half miles from Rockford there are found for the first time ledges of a very coarse, friable graphite, having the same course as the country rock and approximately the same dip. They alternate with the schists and slates and extend to the south western part of Coosa County, where they cross the river and are found at and near Wetumpka, assuming here, as also toward the north east part of the county, a closer grain and firmer texture. At Goodwater, a station on the Columbus and Western Railway, in the north east part of the county, the granite becomes much harder and is suitable for building purposes. Lying in immediate proximity to the granite towards the east there occur ledges of a coarse graphitic schists carrying thin seams of quartz and pyrite, and conforming in dip and strike to the contiguous rocks. At times these quartz seams become quite large, as in the W. ½ S. W. ¼ Sec. 14, T. 22, R. 18, one and a half miles west of Rockford, where one of ten feet in width may be seen between two ledges of granite. This quartz carries tourmaline and tantalite, considerable fragments of this latter mineral having been found on the surface of the ground during the last ten years. A piece weighing 16 ounces, now in the Geological Museum at the University of Alabama, was obtained here besides many smaller pieces. It occurs in scattered fragments and occasionally imbedded in quartz.

(For Prof. Tuomey's description of the metamorphic rocks and the granite of Coosa County, see Appendix C.)

In immediate association with a ledge of coarse granite, a quarter of a mile north east of the tantalite locality, I picked up from the surface of the ground nearly two pounds of Cassiterite, the oxide of tin, some of the crystals measuring half an inch across the face and exhibiting an excellent crystallization. Dr. Eugene A. Smith, State Geologist, was the first to examine this locality for tin, which he did in or about 1880. In 1884 Hon. John S. Bentley, Probate Judge in Coosa County for 18 years, sent a box of minerals from Coosa County to the elder Dr. Chas. Shepard, in which were some crystals he thought were cassiterite. In his reply Dr. Shepard told him to look out for tin. In the American Journal of Science for 1884 will be found a brief mention of the matter. Here, however, it rested. No one had examined the place critically, and it seems to have been forgotten that tin had been found there. The honor of the discovery belongs to Dr. Smith. The only share I have in the matter is the further identification of the crystals as cassiterite and the securing of the largest quantity of tin ore as yet obtained in this State, about two pounds of pure crystals. I say pure crystals, for I sent a sample to A. R. Ledoux & Co., 9 Cliff St., N. Y., for analysis, while I was still in the field, and received a report from the firm that the crystals contained 78.19 per cent. of tin, theory requiring 78.68 per cent.

Investigations are now being conducted in this locality, and it is hoped that before long some interesting results will be reached. My attention was drawn to the matter first by Judge Bentley, whom I visited at his house near Rockford, Aug. 4th, 1891, and again on Aug. 13th and 14th. He told me of the occurrence of tin ore on his land and I examined the place August 5th, and again on the 14th with his son, William H. Bentley, the Judge at that time being unable to walk, having been stricken with paralysis in 1887. For more than twenty years he had been a most indefatigable investigator of the mineral wealth of the county, and indeed while I was there, although he could not take a single step nor help himself into and out of his chair, he had his servant to place him in his buggy and went with me over a considerable part of the district.

Judge Bentley was a remarkable man; always alive to the best interests of the county, popular with all classes of citizens. His untimely death, which occurred in January, 1892, removed from Coosa County one of the best of men as also one of closest observers of natural phenomena I have ever had the privilege of knowing. I can not allow this opportunity to pass without expressing sincere regret that he was taken away at this time, although such a digression may appear out of place in a report of this nature. The State can ill afford to lose such men.

In the same section with the tantalite and cassiterrite i. e. Sec. 14, T. 22, R. 18, on Judge Bentley's land, is found an outcrop of brown iron ore. It shows three feet of fair ore in a trench across the strike, but does not appear extensive enough to warrant hopes of a workable deposit. It seems to be merely a gossan, as the inclosing slates are in many places impregnated with pyrite in various stages of decomposition.

In the bed of the Gin-house branch, as also in the Carroll and Pole branches, contiguous to this locality, gold has been obtained by washing. The gold is derived from the quartz seams held in the slates and is now associated with the gravel resulting from the breaking down and distribution of the quartz. I do not think that the gravel is worthy of any extensive examination, although it may be that some of the quartz seams carry enough gold to warrant investigation.

Almost within the limits of the town of Rockford is an old pit sunk forty or fifty years since for gold. The ore is quartz, walled in slate, strike N. 3° E., dip S. E. 40, width of seam 6 feet. A sample taken from the old dump gave on fire assay:

No. 1311. {Gold............6-10 oz } Value per ton, $12 40.
{Silver...........2-10 oz.}

It was worked several years ago by Mr. Lewis Parsons, of Birmingham, with but little success so far as could be learned. When first opened the ore was roughly crushed and washed at a small stream near by with some profit. It is often the case that such seams near the surface, where atmospheric agencies have been at work for ages, will yield enough gold by the simplest processes to pay for the labor and give more or less of a profit besides. But as the ore becomes harder, and more especially when sulphurets begin to appear, as is almost universally the case, the crude methods of fifty years since will not suffice. This is the main reason why so many abandoned pits, shafts, &c., are to be seen in all parts of the gold belt.

Near Hissop postoffice, on the land of F. M. Darsey, I observed a close grained granite in association with a highly metamorphosed clay slate, in Sec. 14, T. 22, R. 19, Coosa County. Mr. Darsey afterwards sent me a sample of cellular quartz from near this place but it contained only $2.06 in gold per ton.*

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*Fair crystals of Beryl are found near Hissop.

On the land of E. M. Thomas (Hissop P. O.) in Sec. 11, T. 22, R. 19, is a heavy ledge of a highly graphitic schist inclosed between walls of coarse granite. Mr. Thomas informed me that a few years ago he roasted and smelted some of this schist in a black-smith's forge and obtained from one pound of the rock 35 cents worth of silver. This silver he had made into a collar button and, as proof that the rock contained silver and that he had extracted it, he exhibited the button. I took samples of the schist from the same spot which was said to have yielded the silver but on fire assay it failed to show more than the merest trace of gold, with no silver. As the schist is pyritous the gold may be contained in the pyrite, but certainly it is difficult to believe that from this rock any one had obtained silver on the scale of $700 per ton. From near the same locality I took a sample of bluish-green mud which Mr. Thomas also assured me contained silver, as he had himself run it out. On fire assay it gave the merest trace of metal.

On the land of Harris McKinney, in Sec. 6, T. 23, R. 19, and also in Sec. 1, T. 22, R. 19, Coosa County, there is said to occur a seam of magnetite. I examined the same seam in Sec. 31, T. 23, R. 19, at Mr. McKinney's house, where small peices of a slightly magnetic brown ore are found on the surface, but I am not of the opinion that magnetite in any quantity will be found in the vicinity. The ore is derived from the oxidation of local seams of pyrite in the schists and slates and even now pyrite may be observed in immediate proximity to the ore. I obtained at Mr. McKinney's house a peice of sugary quartz representing a seam said to be on his land. On assay, however, it gave:

No. 1309.	Gold.........2-10 oz.	Value per ton, $4 13.
	Silver.........trace.	

The road from Rockford to Kellyton runs for 14 miles in a course a little N. of E. Many ledges of coarse granite are crossed, alternating with bands of slate and graphitic schist carrying in places evident signs of pyrite. This mineral seems to have been pretty well distributed in these slates and schists, almost any peice of rock which has not suffered atmospheric decomposition will exhibit small crystals of pyrite. In certain localities where the pyrite was to some extent concentrated and where it has been decomposed there will be found fair indications of brown ore. I have seen seams of three feet and more in thickness and apparently indicative of a workable deposit. While pyritous quartz and even pyritous slates do, in some places, suffer so great a decomposition as to allow of the utilization of the residual oxide of iron, yet I do not think that the seams of brown ore in this part of Coosa County will be found to be of this kind. The same opinion has already been expressed as to the brown ore of south-east Chilton, for while the amount of visible ore there is far greater than in any part of Coosa County visited, still it has been derived from the enclosing slates in the same manner and is, in my opinion merely the residue of probably much more extensive seams now removed by erosion. I would not be understood as saying that ores derived from the enclosing rocks are, per se, and for this very reason unreliable. The elaborate and most conclusive researches of Sandberger, von Cotta and others have long since established that many of the most valuable ores are thus derived, notably the ores of the precious metals. But there are ores and ores, conditions of enclosure favorable to richness and conditions unfavorable, and it seems to me that in the case of all the brown ores mentioned in this report, we have the latter set of conditions. I am aware that this view of some of these brown ores is not held by some men whose opinions are worthy of consideration, but an acquantance with the brown ores of this State, North Carolina and Kentucky warrants me in taking the position occupied.

It was hoped that during the progress of the survey some indications of the existence of workable iron ore would be found in this part of Coosa County; that is, from the Coosa River through Rockford to the line of the Columbus and Western Railway; but none were found, although to the eastward of Rockford three lines of investigation were carried on. One from Rockford to Kellyton along the mail route, one from Rockford to Alexander City by the lower road, and one to the south east part of the county in the vicinity of Equality P. O. and beyond into Elmore County four miles. This last named examination was conducted by Mr. E. E. Newton, a recent graduate of the University of Alabama, who was with me as a volunteer assistant. Not only were no iron ores of any importance found, but with the exception of the Alum Bluff and the Rockford Mine, the quartz examined yielded mere traces of gold and silver.[*] In my opinion, the more northern portions of Coosa County will probably be much more productive of gold ores than the middle and southern portions. (See appendix C.) It was my intention to return through this part of the county later in the summer and to remain there for some time, but the serious illness of a member of my family compelled me to abandon the survey before this could be done.

That portion of Chilton County lying north of Clanton and east of the Louisville and Nashville Railway, was also to have been examined later in the summer, but for the same reason had to be left to some future survey. This report is to be taken as a reconnoissance of the Lower Gold Fields, to mark out those portions of the Field that are worthy of a more extended examination, so that in the future the energies of the Corps should be spent upon ores that can be worked at a profit. That such do exist in this

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[*] No. 1,325. Reddish crystalline quartz, showing free Sulphur from land of Mrs. Nancy Bryant, Sec. 29, T. 21, R. 20, Coosa County.
Gold..... } Traces.
Silver..... }

No. 1326. Sugary quartz, Equality P. O., Sec. 31, T. 21, R. 20, Coosa County.
Gold...... } Traces.
Silver..... }

No. 1327. Sugary quartz, Sec. 18, T. 22, R. 17, Coosa County.
Gold—1-10 oz per ton.
Silver—trace. Value per ton, $2 06.

No. 1328. Sugary quartz, Sec. 28, T. 25, R. 20, Coosa County.
Gold...... } Traces.
Silver.... }

Nos. 1,321 to 1,324, inclusive, are assays of reddish crystalline quartz, from the land of J. W. Willingham, in Sec. 10, T. 20, R. 4, Elmore County, but only one showed more than traces of gold and silver, and that one contained 1·10 oz. of gold per ton ; value per ton $2.06.

Field is to my mind beyond question, and I think I know something of the conditions of gold mining along the Appalachian Range. It is my deliberate opinion that Alabama offers great inducements to the gold miner, and that capital judiciously invested and economically administered in the extraction of the precious metals would, in this State, find ample returns.

TALLAPOOSA COUNTY.

I propose now to discuss that part of the Lower Gold Field which seems to me to offer these inducements and to hold out these promises of profitable investment.

I refer to Tallapoosa County, long known, with Cleburne County, as the scene of the greatest development in gold mining to be met with in the State, a place famous among the placer miners and quartz crushers of fifty years ago, and which has yielded a large part of the gold credited to the Southern States between the years 1830–1850.

In the adventures of Captain Simon Suggs, written to describe the truly remarkable experiences of this truly remarkable person, Johnston Hooper incidentally mentions a circumstance which bears upon the history of the gold fever in this part of Alabama. The Captain had bargained for a certain piece of land belonging to a Creek widow. When the time for payment drew near he found himself without the necessary funds to complete the trade, a condition of affairs by no means uncommon with him. Other speculators desired the same piece of land, and offered the widow much more than the Captain had agreed to pay, but she steadfastly refused to deal with any one but with her friend, Captain Suggs. She was beset on every side, but nothing could be done. It was known to the others that the Captain had no funds, and they supposed that in the end he would be forced to say so, when they expected to come in for something good. The Captain disappeared from the Post for several days, and no one knew what had become of him, although he intimated that he was going to borrow some money from a friend. Finally when the widow seemed upon the point of concluding that he had left the country and was about to sell the land to some one else, he rode up, dismounted and joined the crowd with an enormous pair of saddle-bags on his arm, heavily laden. The speculators at once concluded that he had "struck it rich," as the saying was and is to this day; there was no telling, gold was plentiful then and many good nuggets had been found, and many a fifty pounds of ore that would pay for the land many times over. They at once came to terms and bought from him the coveted quarter section for two and a half times what he had agreed to pay for it. When the bargain had been firmly arranged and the money paid, he quietly threw out from the saddle-bags a lot of worthless rocks picked up along the road. All this happened in what was then Tallapoosa County about the year 1835, and illustrates in a striking manner the rage for speculation. The throwing open of much valuable land for settlement, consequent upon the removal of the Creek Nation, was responsible for much of it, but the genuine gold fever is to be credited with the greater part.

It is most unfortunate that no reliable statistics of the number of miners, or the yield of gold or the cost of the operations are now to be had, but from the trustworthy tradition and from what I have myself seen over a large part of the district in question, there can be no doubt of the activity that prevailed at that time among the gold miners in Alabama. It is said that in the adjoining county of Cleburne the town of Arbacoochee, now containing less than three hundred people, had in 1845 some five thousand inhabitants. From 1830 to 1850 the prospector was a familiar figure along the roads and among the hills of Tallapoosa.

GOLDVILLE BELT.

From Hillabee Bridge, six miles east of Alexander City, to and beyond Goldville for a distance of 14 miles, an almost unbroken line of pits, trenches and shafts bear witness to-day of the great amount of work done prior to 1855. A mere enumeration of some of these old workings, which may be seen and in part explored, even now will show to what extent these operations were conducted. Thus, from a point half a mile above the bridge to the Birdsong Pits beyond Goldville, we have

	Section,	Township,	Range.
Ulrich Pits	8	23	22
Mahan Pits	4	23	22
Croft Pits	34	24	22
Stone Pits	34	24	22
Ealy Pits	26	24	22
Log Pits (Tog Pits is incorrect.)	24	24	22
Houston Pits	18	24	23
Goldville	8	24	23
Germany Pits	8	24	23
Jones Pits	5	24	23
Birdsong Pits	4	24	23

These by no means exhaust the list; there are others which in their day were quite as well known and quite as productive, but whose exact location is now unknown.

It will be seen by consulting any map of Tallapoosa County, or the new State map, that these old workings follow each other in the order given from south west to north east. They do not appear upon either map, but by laying a straight edge along the map from Alexander City to Goldville, they will occur in almost a right line, the Ulrich Pits being the most southwesterly and the Birdsong the most northeasterly. Of the history of these mines little or nothing is known. The only mention of any of them which I have been able to find is a brief note by Oscar M. Lieber, in the Second Report on the Geological Exploration of the State of Alabama by M. Tuomey, published in 1858.

This Report was posthumous, and was edited by J. W. Mallett, now the distinguished Professor of Chemistry in the University of Virginia. He says in his Preface that the Report was drawn up by Prof. Tuomey in November, 1855, and was presented to the State Legislature at its Session of 1855–56. The information it contains is therefore such as was available prior to 1855, although the Report was not printed until 1858. On page 64 of this Report Prof. Tuomey says of Goldville: "The gold mine of this place was discovered in 1842, and was worked to water level. The most noted portion of the mine was known as the tog pit." (There must be an error here, for Col. B. L. Dean, of Alexander City, who has known that district very well for thirty-five years, informed me that the name of 'tog pits' was entirely unknown there. Prof. Tuomey evidently referred to the Log Pits, which, however, are three miles south west of Goldville. W. B. P.) Prof. Tuomey continues: "the richest part of the vein in this pit (what he calls the tog pit) was from 4 inches to 2 feet thick. It was quartz in talcose slate, and yielded 2½dwts. to the bushel of ore. The gold was worth 90 cents to the dwt. Almost $30,000 worth of gold was extracted from this pit, and from this the proprietors received in addition $80.00 in silver. The history of this mine is like that of all Southern gold mines—the total want of any practical system of operations." This mine, Mr. Lieber reports, has been recently re-opened. "A vein has been discovered which, from its curious contortion, is called the snake vein. In the south side of the shaft it is poor, but in the northern side it yields on an average one dollar per bushel. The ore is a friable, porous, ferruginous quartz. The country is talcose slate, decomposed as far as yet reached. Numerous other veins appear on the same property, and properly managed success may be anticipated. The minerals found here, besides gold, are magnetic iron sand, native sulphur, garnets and mica." Thus far Prof. Tuomey.

As to the Ulrich Pits, it may be said that some forty or fifty years ago a German named Ulrich had a vineyard here and opened the gold pits. He mined and crushed in a crude way a considerable amount of the ore and is said to have made a good deal of money. The ore is a free milling sugary, and crystalline quartz, stained with oxide of iron, and held in a tough micaceous slate, strike North 30 deg. East, dip 40 deg. S. E. There are visible six seams of quartz, the largest six feet in width and the smallest three feet. They are separated by bands of slate, and the entire six seams are comprised within a distance of three hundred feet. They outcrop on a hill above Hillabee Creek, at elevations above the creek of fifty to one hundred and fifty feet. The 530 foot line of altitude runs at the base of the hill at the creek. The pits are now fallen in, as well as the drifts, but the nearest pit to the creek is distant three hundred feet. There is always a bountiful supply of good water in the creek and it never rises to the first opening. All of the work done was on the north side of the creek, for, although the creek cuts all of the seams, nothing has been done on the south side. Mr. Ulrich seems to have cut into the ore while excavating a wine cellar. The deepest pit was sunk fifty feet and is now fallen in and inaccessible in the lower levels. Several drifts were started in to cut the ore at depth and it was found to be of good quality. While a considerable amount of ore was taken out, from first to last, the main body was hardly touched, and there still remains a large amount of free milling quartz within one thousand feet of the creek. From several old dumps I secured samples of the ore which gave by fire assay from $2.06 to $8.46 per ton. (See table of assays along Goldville Belt, pp. 45 and 46).

One of the quartz seams on the Ulrich place crosses the Hillabee Bridge road about three miles from Alexander City, on what is known as the Duncan Place, one mile south west of the Ulrich Pits. Here it is 2½ feet thick, held in the same slate. A sample gave, by fire assay,

Gold	2 10 oz. per ton.	Value per ton $4.13.
Silver	trace.	

From this point this seam of quartz and others in close proximity extended in a north east direction for twelve miles to and beyond the Birdsong Pits. I have closely observed the character of the quartz over this distance and it differs but little from that at the Ulrich Pits. Scores of old pits, trenches and shafts are found. I do not think that any half mile between Duncan's and Birdsong's will fail to show evidences of former operations; some of them, for that day and time, quite extensive.

Over this entire distance of twelve miles the quartz seams are bold and strong, preserving the same general characteristics, and showing a remarkable continuity of walling, strike and dip. In places, as for instance at the Jones Pits, where the greater part of the old time work was done, they thicken up to thirty feet. Nothing of any moment has been done at any of the Pits for more than thirty years. Between 1835 and 1860, it is said that several thousand miners were at work along this range, but in 1850 they began to drift towards California, and this migration, with the disturbing effects of the civil war, put an end to the operations. A large amount was certainly taken out and treated, but with what results as to profits can not now be known. The country was then very thinly settled and all the supplies had to be hauled for 50, 60 and even 70 miles over roads that, for the most part, were simply execrable.

No records were kept of the amount of ore treated or the yield, and it would now be a hopeless task to endeavor to ascertain the out-put of gold or the cost of production. From a careful examination of the localities, the nature of the ore and the conditions under which the work must have gone on, it is, I think, evident that the operations must have been, in places, very profitable.

No organized capital was employed and there were no mills worthy of the name. But little was known of the art of mining, and still less of the art of milling, the most important consideration in the successful management of all gold ores, and there must have been a large loss of gold. Yet the work went on for years, some of it costly work. The only explosive they had was black powder; all of the drilling was done by hand and a great deal of the crushing also. But they kept at it, and the engineer who examines the district to-day can see for himself that an astonishing amount of ore was raised and treated. The old openings are now abandoned, large trees are growing in the pits and trenches and the shafts, some of them more than fifty feet deep, are gradually filling up with leaves, rotten timbers and debris from the walls. Gold mining in the Goldville District is unkempt, ragged and down at the heels.

At Goldville itself, between 1840 and 1850, there are said to have been fourteen large stores with a contributory population of at least 3,000. Now one looks in vain for the tenth part of this population, and the stores have been converted into dwellings and barns.

It must, however, be distinctly stated that the mining operations conducted forty and fifty years ago along this belt merely scratched the great deposits of free milling quartz that characterize it.

Above water level, i. e., at depts varying from 10 to 40 feet, these seams furnished a material much more friable and easily crushed than was found at greater depths. The gold was coarser, and the absence of any considerable amount of sulphurets allowed free malgamation. At few places along the belt, for a distance of 10 miles, did these old miners, so far as could be ascertained, penetrate to the the lower limit of the decomposed sulphuret. At one place only did I observe the presence of undecomposed and decomposing sulphuret, viz: at the Jones pits, in Sec. 5, T. 24, R. 23, near the north east extremity of the Goldville Belt. Here the undecomposed sulphuret of iron, with arsenopyrite, began to come in at the the bottom of a shaft 60 feet deep. It is held in a hard, bluish quartz showing also free gold. A sample, which showed no free gold, gave by fire assay,

Gold......2 7-10 oz. per ton. } Value per ton \$55.90.
Silver.....1-10 " " " }
(See also page 48.)

It is highly probable, and, in the light of universal experience in the South Atlantic Gold Fields, even certain, that the free milling ores, that is, such ores as readily yield their gold to mercury, begin to carry sulphurets below water level. As these come in the free gold goes out, and when a typical sulphuret ore is found, it contains about one third of its total gold in such a condition as that quicksilver will attack it. The other two-thirds can not be extracted with quicksilver at all unless the ore is thoroughly roasted, and even then incompletely. Forty years ago such an ore was almost worthless in a district affording no smelting ores. To be available at all it had to contain sufficient free gold, easily taken up by quicksilver, to pay for the mining and treatment of the whole amount of ore and leave something over for profit.

Gold exists in quartz seams in at least two conditions. First, as free gold, more or less fine and intimately mixed with the quartz. Second, combined, or mixed, with a mineral consisting of iron and sulphur, or iron, copper and sulphur, known as Pyrite, or Chalcopyrite. Generally the mineral occurring with the gold is pyrite, or, as it is briefly termed, sulphuret, meaning a compound of iron and sulphur. This sometimes contains copper, but in the Southern States rarely beyond two per cent. When this sulphuret is exposed to the atmosphere it begins to decompose, the product being oxide of iron, a reddish or reddish-brown substance, which remains, and sulphate of iron (copperas) which, being soluble in water, is washed away.

All the quartz seams of the Goldville Belt seem at one time to have carried sulphuret disseminated through the quartz. The sulphuret has been decomposed down to water level, so that now these seams show, above this point a friable quartz penetrated in every direction with thin veinlets of oxide of iron, the remains of the original sulphuret. In many cases the gold carried by the sulphuret is now concentrated along these "iron stains," and on breaking the quartz and rubbing off the stains and panning them, the gold may be panned out, proving that it is now free gold. In the upper portions of these seams all of the gold is now free and is easily taken up by quicksilver. The old time miners, lacking the means for treating the undecomposed sulphuret, ceased their operations when it appeared in any consiberable amount. They mined thus only the upper portions of the seams, from which the gold could be obtained with comparative ease.

Where the decomposition has been going on for ages, as is the case in the Southern Gold Fields, and when the original sulphuret was rich and plentiful, it often happens that the residual oxide of iron forms veins of several inches in thickness and carries much gold. In the Rudisill Mine, near

Charlotte, N. C., there was a vein of this oxide of iron, along with other ores, about four inches thick that went down to a depth of 300 feet, and carried in places nearly $500 worth of gold per ton. At the Boilston Mine, in Henderson County, N. C., I have also observed these veins of iron oxide, one of them carrying $112 per ton. Such veins readily yield their gold to quicksilver, and constitute the best grade of ore in many localities.

One can now appreciate why these old miners made so many pits, trenches and shallow shafts; they were searching for ore that was easy to crush and easy to amalgamate. When they came upon the underlying undecomposed ore, harder and impregnated with sulphuret, they moved on to another place and repeated their operations. But after all, they left an incalculable amount of free milling ore, as the seams of which I speak are continuous for at least 15 miles, and probably extend for 30 miles. Even should this not be the case, assuming that the greater part of the free milling ore had been removed, an assumption by no means to be allowed, we now possess means for the economical treatment of the undecomposed sulphuret, which for ease, rapidity and thoroughness, leave but little to be desired. I refer to the Chlorination of Gold Ores, a full description of which will be found sn Appendix A. The sulphurets, the great Bug-a-boo of Southern gold miners, no longer vex us; they can be and they are treated for their gold contents with the most gratifying success. Apart from the sulphurets, however, and leaving them to be treated when they appear, it is my deliberate opinion that between Hillabee Bridge and the Birdsong Pits there is enough free milling gold ore to maintain a dozen stamp mills of 200 tons per day capacity at work profitably for twenty-five years. I have been over nearly all of the district twice and do not hesitate to say what seems to me to be the truth. The statement may and doubtless will be received by some with the customary smile of incredulity, the almost invariable accompaniment of assertions regarding the profitable treatment of Southern gold ores. The same smile did duty when the first assertions as to the Southern iron ores were made, when the Florida Phosphates were discovered and when coke making was begun in Alabama, and is still in good working order. It is as old as human nature and will outlive the last man.

In my examination of the Goldville Belt, extending from Hillabee Creek in a general north east direction to the Birdsong Pits, a distance of about 14 miles, I was particularly fortunate in having as my companion and guide Col. B. L. Dean, of Alexander City. He has been a resident of this part of Tallapoosa County for 36 years and has devoted more intelligent attention to the mineral wealth of the county than any one I know of. He is especially well acquainted with the region east of the Columbus and Western Railway and north of the Tallapoosa River. At my request he wrote a brief account of the Goldville Belt and I reproduce it here in his own words:

"The first work in this part of Tallapoosa County was done between 1840 and 1850 by Edward Birdsong, who has been dead for thirty odd years. He owned and mined part of S. W. ¼ and N. W. ¼ of Section 4, T. 24, R. 23. His widow, a resident of Columbus, Ga., was living in 1889. She could give more information about the mining interest in those days than any one I know. She said to me once that she was the cause of her husband's stopping work; the country was full of miners and she could not afford to raise her children where the Sabbath was a day of hunting and gambling. Her husband's work was carried on with negroes. In illustration of the gold fever she said that her negro cook, after attending to all of her duties at the house, would take her pan and wash out 75 cents worth of gold in a day, crushing the ore in a little hand mortar.

"Towards the south west we come next to the Jones Pit, in Sec. 5, T. 24, R. 23. On this property a great deal of work has been done with wooden stamps and the Arastra. There was also at one time a steam engine at the mine. Reports as to the yield of gold vary. The veins are from ten to twenty feet in width. (I have heard old miners say that in places the Jones Pits were very rich, W. B. P.)

"Next towards the south west we come to the Germany Pits, in the N. W. and S. W., Sec. 8, same township and range. It is said that Mr. Germany made money here. In this Section is located the town of Goldville, one of the oldest places in the county.

"Next in order are the Houston Pits, where much work has been done, but I know very little about them.

"The Log Pits are next, where also much work has been done.

"Next are the Ealy Pits in the S. W. ¼ of Sec. 26, T. 24, R. 22. A great deal of work was done here by Mr. A. Ealy and the Hon. Daniel Crawford, Ex-State Treasurer. Col. Crawford had great faith in this part of the county and was always on hand when any work was going on. I asked him once how he worked the Ealy Pits. He said that he made the machinery himself; four iron-shod wooden stamps run by water power at Jarvis' Mill. He hauled the ore two miles, crushed it with the wooden stamps and then "rocked" it in a rocker. I inquired what was the best run he had ever made in one day, and my recollection is that he said it was $73 or $75. After the death of Mr. Ealy, work was suspended, probably in 1845 or 1846, and has not been resumed since. I met a man once, named Collins, living in the northern part of the county, who had worked at the Ealy Pits and he told me that Ealy and Crawford got out some ore that ran $41 to the bushel. (Taking the bushel at 100 pounds, this ore was worth $820 per ton; pretty good stuff for those days. W. B. P.)

"Of the Stone and the Croft Pits, which come next, I know but little. A good deal of work was done from first to last, but nothing of record.

"The Mahan Pits, which come next, seem to be in the slate and a little off the main line of the quartz. Heavy sulphurets begin to show at the Mahan Pits, but the ore carries also free gold, as I have panned it out. Some of the ore was sent north several years ago by a Mr. Linds, and it assayed $22 per ton.

"Lastly, we come to the Ulrich Pits on the east bank of

Hillabee Creek. A great deal of work has been done here also, and much money spent to no purpose in shafts and drifts. The quartz is walled in slate dipping in some places nearly vertically, but as a general thing not above 45 degs. Dr. Ulrich sunk several costly shafts, hunting for copper, but as they were put down on the west side of the veins while they dip towards the east, the deeper he went the the farther he was from the ore. He finally discovered gold instead of copper, and erected a mill furnished with wooden stamps, taking the water for his power from Hillabee Creek. He worked in this way until the war, making his gold into bars and buying cattle with it, so I am informed by old citizens. Ulrich's operations were conducted without the least regard to economical mining, and with no thought for the future. The showing of ore at these pits and at the Jones Pits is greater than at any intermediate locality, and at these two places water is much more abundant and accessible than anywhere along the belt. Col. A. H. Moore had some of tho Ulrich ore assayed in North Carolina, and told me that it ran $21 per ton

"On the west side of Hillabee Creek these seams continue in a south west direction, crossing the road from Alexander City to Hillabee Bridge on the the Duncan Place. This belt seems to be bounded on the east by a large slate dyke from 200 to 400 yards distant from the quartz seams. It crosses the Columbus and Western Railway in Coleman's Cut. This ends what I have to say about the Goldville Belt.

"About two and a half miles west of the Log Pits we find a great mass of ore in the Hog Mountain. There are millions of tons of quartz in the Hog Mountain, all of it carrying gold. I saw assays of ore taken from 16 different places and they showed the ore to be worth from $4 to $16 per ton. (Other assays of Hog. Mt. ore will be found under the appropriate heading, W. B. P.)

"From Hog Mt. we come south, in the same section to where William Conant worked in 1844 and 1845. It is said that he made money, using the crudest appliances and hauling the ore two miles with oxen.

"In Section 5 we find gold in the slates and heavy sulphurets in the shoals of Enittachopka Creek, the sands all along the creek for miles will pan gold.

"In all these places the quartz seams appear to go in parallel bands six or seven in a group and from thirty to forty feet apart. The same is true of Hog Mt."

This concludes Col. Dean's interesting and valuable letter. If there were others in the country who took the same intelligent means of informing themselves as to what has been done and what still remains to be done to develop legitimate gold mining the task of the prospector would be easier. He has faith in the future of Tallapoosa county as a gold producer and whether his hopes are fulfilled during his lifetime or not he may, perhaps, from another sphere be able to look down upon a score of mills, pounding away and proving the reality of what he labored so long to establish, the profit in quartz mining along the Goldville and Hog Mt. Belts.

Following is a list of the assays made on small samples taken along the Goldville Belt from Hillabee Bridge to the Jones Pits. It is not claimed for these assays that they represent in every particular the value of the ores, still they will show their general character. To sample these seams correctly would cost a good deal of money and the Survey has no means at its disposal for such an undertaking. The owners of the property should take the matter in hand, employ a competent engineer and furnish him with the means for opening the old pits or sinking new ones, so that average samples could be secured.

Assays along the Goldville Belt from the Duncan place, on the Hillabee Bridge road about 3 miles from Alexander City to the Jones Pits. Fourteen assays were made along this line, viz: one from Duncan's, five from the Ulrich Pits, two from the Ealy Pits, five from the Jones Pits, and one from what is known as the Chisolm Place, in Sec. 9, T. 23, R. 22. The value of the ore varies from $2 to $55.90 per ton.

No. 1282. Duncan Place, sugary quartz 2½ ft. width, sample from seam in road,

Gold......2–10 ozs. per ton. } Value per ton, $4.13.
Silver.....trace.

No. 1283. Ulrich Pits, old dump, reddish sugary quartz:

Gold......1–10 oz. per ton. } Value per ton, $2.06.
Silver.....trace.

No. 1284. Ulrich Pits, old dump, reddish sugary quartz.

Gold......4–10 oz. per ton. } Value per ton, $8.36.
Silver.....1–10 oz. per ton.

No. 1285. Ulrich Pits, old dump, reddish sugary quartz:

Gold......1–10 oz. per ton. } Value per ton, $2.06.
Silver.....trace.

No. 1286. Ulrich Pits, old dump, reddish sugary quartz:

Gold......1–10 oz. per ton. } Value per ton, $2.06.
Silver.....trace.

No. 1287. Ulrich Pits, old dump, reddish sugary quartz:

Gold......4–10 oz. per ton. } Value per ton, $8.46.
Silver.....2–10 oz. per ton.

No. 1288. Ealy Pits, yellowish sugary quartz:

Gold......1–10 oz. per ton. } Value per ton, $2.06.
Silver.....trace.

No. 1289. Ealy Pits, yellowish sugary quartz:

Gold......1–10 oz. per ton. } Value per ton, $2.06.
Silver.....trace.

No. 1290. Jones Pits, yellowish crystalline quartz, old dump:

Gold......1–10 oz. per ton. } Value per ton, $2.06.
Silver.....trace.

No. 1291. Jones Pits, old dump, reddish crystalline quartz:

Gold.. } traces.
Silver.

No. 1292. Jones Pits, old dump, white crystalline and bluish quartz, with pyrite, and Arsenopyrite i. e. pyrite containing arsenic:

Gold .....2 7–10 oz. per ton. } Value per ton, $55.90.
Silver.....1–10 oz. per ton.

No. 1293. Jones Pits, old dump, white crystalline quartz:

Gold......1–10 oz. per ton. } Value per ton, $2.06.
Silver.....trace.

No. 1294. Jones Pits, old dump, white crystalline and bluish quartz with pyrite and arsenopyrite.

Gold......9–10 oz. per ton. } Value per ton, $18.90.
Silver.....3–10 oz. per ton.

No. 1299. Chisolm Place, out crop of whitish sandy quartz, 6 ft. wide.

Gold......1–10 oz. per ton. } Value per ton, $2.06.
Silver.....trace.

HOG MOUNTAIN.

Copy of a letter received from Col. Jas. P. Dawson, Turner Building, St. Louis, September 18th, 1891:

St. Louis, Mo., Jan. 22d, 1889.

Elias S. Pepper, Esq.,
3rd National Bank, City :

Dear Sir—The sample of ore from..........marked.........., submitted to us for examination, contains

Gold......2.65 ozs. per ton.
Silver.....0.10 " "

Respectfully,

St. Louis Sampling and Testing Works,
William B. Potter, Mgr.
"S."

According to this assay the ore is worth $54.87 per ton. The letter was marked in pencil "Jones Vein."

In regard to the foregoing analyses I can only reiterate what has been already more than hinted at, that if the owners of gold properties desire assays which shall correctly represent the character and value of the ore, they should employ a competent and reliable mining engineer to make a detailed report. Samples taken at random may be correctly assayed and yet reveal but an indication.

Four miles almost due west from Goldville, two miles east of Hillabee Creek, and the same distance south from the Tallapoosa, Clay, line in Secs. 10 and 15, T. 24, R. 22, in Tallapoosa County, is the famous Hog Mountain. It derives its name from its peculiar shape when viewed from a distance. It attains an elevation of about 1,000 feet above tide and about five hundred feet above the surrounding country. It is composed in great part of quartz seams separated by bands of clay slate, highly metamorphosed in many places. A ledge of coarse granite appears among the slates of the hanging wall, i. e., the south wall, for the seems here are orientated contrary to the general run of the quartz in this part of the county. They bear almost due east and west, and, with the slates, appear to have been twisted around, the normal course being towards the north east. On the west side of the mountain there are enormous outcrops of quartz seams and massive boulders of quartz. One of the seams, known as the Blue Seam, shows 35 feet in width where it is uncovered. This seam was worked to a limited extent several years ago, and some good ore was taken out.* It bears east and west and dips to the south 30 degrees.

There is now a ten stamp mill, California pattern, with engine and boiler on the property, but no work has been done for several years. From the appearance of the more recent openings I think that perhaps 500 tons of ore were mined and milled, but I have as yet been unable to ascertain with what success. The ore is a sandy, friable quartz near the surface, but soon begins to harden, and at a depth of 15 or 20 feet is quite hard. At a depth of 20 feet in the Blue Seam sulphurets begin to come in and carry gold, as will appear from the assays.

The Tallapoosa Mining Company, of St. Louis, is now preparing to begin the work at the Hog Mt. on an extensive scale, so it is said. With a modern mill crushing from 200 to 300 tons per day, there is no reason why the Hog Mt. should not enter the list of profitable mines. There are millions of tons of workable ore in this hill. The main draw-back to any considerable operations here is the scarcity of water; there is no sufficient supply nearer than Hillabee Creek, 1½–2 miles. For this reason, and on account of the character of the ore, any company wishing to work on a large scarle would have to expend a great deal of money. The difficulties to be met and overcome, however, are no greater than have been successfully encountered elsewhere.

Through the kindness of Col. Jas. P. Dawson, Turner Building, St. Lonis, I can present some additional information concerning the ore from Hog Mt.

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*About one mile from the Hog Mt. towards Cowpens Tourmalne is abundant.

"Alexander City, Ala., May, 1889, pannings made on Hog Mt. by Wm. H. Cornell:

Veins.	No. of pans.	Showed gold.
1x2	11	7
2x3	9	6
3x4	20	13
4x5	10	8
5x6	12	7
6x7	8	4
7x8	5	5
8x9	6	4
9x10	4	2
	85	56

These pannings were all taken from the surface, and as near in diagonal as possible. The show was from three to thirty particles to the pan. From 3x5 the best."

Another letter from Col. Dawson enclosing two from Mr. Jewett, Assayer in charge, United States Assay Office, St. Louis, was received at the same time. From the assertions of Mr. Jewett in regard to some ore which Col. Dawson informs me was from Hog Mt., I find that it was worth $8.26 in gold and 36 cents in silver per ton.

Copy of a letter from the St. Louis Sampling and Testing Works:

"January 11th, 1889.

T. Wright, Esq., 3d and Olive Sts., City:

Dear Sir—We herewith enclose certificate of assay. The concentrates weighed 1.870 grams, 28.85 grains. If obtained from two ounces avoirdupois this would be a concentration of over 30 to 1. Unless the assay of the original is known, it would be impossible to say what loss attended the process.

Very respectfully,
St. Louis Sampling and Testing Works,
Wm. B. Potter, M'g'r."

S.

This letter is marked, in pencil, "Hog Mt." The certificate referred to was as follows, as per copy:

"St. Louis, Mo., Jan. 12th, 1889.

T. Wright, Esq.,
3d and Olive Sts., City:

Dear Sir—The sample of Pulp from............marked "Concentrates," submitted to us for examination contains

Gold..................4.37 ozs. per ton.
Silver................2.92 " " "

Respectfully,
St. Louis Sampling and Testing Works,
Wm. B. Potter, M'g'r. J."

Taking the total value of these concentrates at $93.24 per ton and the degree of concentration as 30 to 1, the value of the untreated ore would be $3.10 per ton.

Copy of a certificate of assay of what Col. Dawson wrote was "a number of pieces picked up at random on the mountain and assayed together."

"St. Louis, Mo., April 22d, 1889.

T. Wright, Esq.,
3d and Olive streets, City:

Dear Sir—The sample of ore from..........., marked............, submitted to us for examination, contains

Gold....................0.3 ozs. per ton.
Silver..................0.1 " " "

Respectfully,
St. Louis Sampling and Testing Works.
William B. Potter, Manager."

Taking these figures, the value of the ore per ton was $6.20.

Copy of another letter received from Col. Dawson:

"St. Louis, Mo., Oct. 2d, 1889.

T. Wright, Esq.,
3d and Olive streets, City:

Dear Sir—We have treated the barrel of ore you sent us as follows: The ore was crushed in a three stamp gold battery, with inside and outside amalgamated plates, using a 40 mesh screen, and the tailings were run over an Evans concentrating table with the following results:

Net weight of ore	502 lbs.
Containing gold	1.90 ozs. per ton.
" silver	0.1 " " "

The amount remaining in the mortar after the run was 219 lbs., assaying 1.90 ozs. gold per ton, thus giving 283 lbs. as the net weight of ore treated. The tailings from the plates contained, Gold........0.50 ozs. per ton, showing a saving of 73.7 per cent of the Gold.

The tailings, after passing over the Evans Table, gave the following results:

Headings	11 lbs., containing
Gold	1.60 ozs. per ton.
Silver	0.10 " " "
Middlings	48 lbs., containing
Gold	0.35 ozs. per ton.

The Headings contain 3 per cent of the Gold in the original ore, but it will be noticed that their grade is a little lower than the original ore.

The above results would indicate that your ore is fairly free milling. With a larger amount of ore, sufficient to make several runs under varying conditions, it is possible that somewhat better results might be obtained.

Respectfully,
St. Louis Sampling and Testing Works,
William P. Potter, Manager.
J."

According to this assay the ore was worth as follows:

Gold	$39.27
Silver	.10
	$39.37 per ton.

The following letter, also from Col. Dawson, is very important, showing as it does that at one time much more information concerning the Hog Mt. ores was available than is now the case.

"St. Louis, Sept. 8, 1891.

James P. Dawson, Esq.,
President Tallapoosa Mining Co.,
City:

Dear Sir—Replying to your inquiry concerning assay work done by my direction on Hog Mountain ore, I have searched all through my papers for the records but could not find them, and I do not know what I did with them. I had very many assays made, perhaps sixty or seventy, of the ore taken from different parts of that property, and of course can not remember them. I do remember that they ran as low as $2 and as high as $31, and I believe that they averaged $7.50, and I believe that they represented perhaps the true character of the property more closely than any other investigation ever made. I regret very much that I do not have the records, since I would be glad to give them to you.

Yours truly,

A. F. Hoffer.

The assays I speak of were made in '86 and '87."

I made four assays of ore taken at random from some old dumps on the Hog Mt. They ran from $6.20 to $58.67 per ton, the average being $24.53. They are as follows:

No. 1,295.	Hog Mt., old dump, yellowish sugary quartz. Gold......2 8-10 ozs. per ton. Silver ....8-10 " " "	Value per ton, $58.67.
No. 1,296.	Hog Mt., old dump, whitish sugary quartz. Gold......3-10 oz. per ton. Silver.....trace per ton.	Value per ton, $6.20.
No. 1,297.	Hog Mt., old dump, yellowish sugary quartz. Gold......1 1-10. Silver.....trace.	Value per ton, $22.73.
No. 1,298.	Hog Mt., blue seam, bluish crystalline quartz, with a little pyrite. Gold......5-10 ozs. per ton. Silver.....2-10 " " "	Value per ton, $10.53.

RESUME ON THE GOLDVILLE AND HOG MT. BELT.

1. No work of any consequence has been done for thirty years.

2. No reliable records are to hand relating to the work done prior to 1860.

3. Except at the Ulrich, Jones and Hog Mt. mines no good exposures of the veins are to be seen now. The old workings are fallen in and access to the seams is not to be had except at some expense, and the Survey has no means at its disposal for this purpose.

4. The assays of the samples taken show that the ores vary in value from $2 per ton to $58.67.

5. A large amount of work has been done by the old miners, and by reliable tradition some of it was very profitable.

6. The Ulrich and Jones Pits are well supplied with running water sufficient for extensive operations. The Hog Mt. is from one and a half to two miles from Hillabee Creek, the nearest available water supply.

7. An abundance of good timber of all kinds is within easy reach of all the Pits and of Hog Mt.

8. Profitable gold mining could be carried on in this part of the county.

THE SILVER HILL BELT.

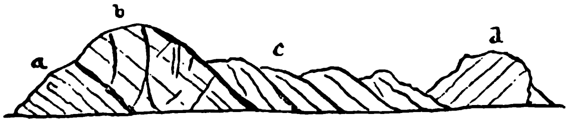
Silver Hill is in Secs. 16 and 17, T. 20, R. 22, Tallapoosa County, and is about 13 miles S. W. of Dadeville. Mining was carried on here probably as far back as 1835, but there are no records of what was done or of anything in connection with the work. There are abundant evidences that a great deal was done from first to last, for the old works are quite extensive, more so than at any locality in the County. A description of Silver Hill is contained in the Report of Prof. Tuomey, previously referred to as having been published in 1858. As he or Mr. Lieber, or both, visited the place before the shafts, drifts, &c., had fallen in as badly as they have now and as the description is well worth reproducing it is here given in full, taken from pages 47 to 50 of that Report.

Prof. Tuomey says:

"The talcose slates of Silver Hill are seen outcropping near Ufola, and the gold mine occupies the crest and flank of the hill which extends to the stream on which the mill is situated.

"The auriferous slates are enclosed between beds of hornblende. The following section will show the position of the mine:

Fig. 1.



Section of Silver Hill (after Tuomey)

a. Hornblende slate.
b. Auriferous talcose slate, with veins of quartz.
c. Dark colored talcose slates.
d. Hornblende slates.

"This section is best seen at the base of the hill near the mill. Both *a.* and *b.* are quite hard, when placed beyond the influence of atmospheric agencies.

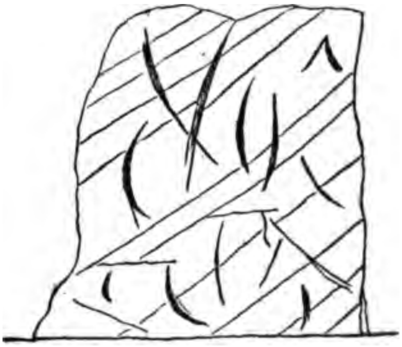
"About ten years ago this mine was in its most prosperous condition. About 150 feet of the principal vein was found out-cropping on the crest of the hill. It was 2 feet thick, but about 12 feet below the surface it became thinner and richer, at a depth of 15 feet it became poorer. It again thickened to 4 or 5 feet, and continued to improve in productiveness until it was abandoned.

"The vein, which was quartz, was worked to a depth of 80 feet in the centre, where it was richest. The ore was there worth $4.85 per bushel (about $96 per ton W. B. P.) The course of the vein was a little North of East. The usual mode of letting out the mine in small parcels was adopted here, and with the same results as elsewhere—the total ruin of the works. The vein is situated in Section 16, Township 20, Range 22. (The range is 21, W. B. P.)

"It has been recently re-opened with some prospect of success. An adit has been driven a little above the natural drainage of the Creek, with a view of striking the vein below the old works. Whilst this heavy work is going on, the proprietors are working some ore from the top of the hill. The ore is hauled by oxen about 250 yards to the mill, where I found 6 stamps, and a badly constructed Burke Rocker, in operation. The ore thus treated yielded only 12½ cents per bushel. (Say $2.50 per ton, W. B. P.)

"The principal vein was not exposed at the time of my visit, but some of the auriferous portions of the country, which were worked, presented the appearance shown in the cut, Fig. 2:

Fig. 2.



Quartz veins. Silver Hill. (after Tuomey)

"The dark lines represent broken quartzose veins containing gold. On the branch, into which the drainage and surface water flows, signs of old works occur in the gravel deposited in its bed. Mr. Lieber, who examined this place more recently, reports as follows:

'The Silver Hill Mines, which were formerly abandoned on account of difficulties among the members of the company, are now worked by a Georgia company, with a prospect of success.

'The country is a talcose slate, one of the beds of which is of that peculiar black kind resembling black lead. Another talcose bed, in which quartz appears in irregular masses, is the one which is worked, the slate being also auriferous. This bed strikes North 70° East, and dips 15° to 35°. A quartz vein, leading from this, and striking North, is about 12 feet thick, including the selvages and the workable slate. The main body is 8 feet thick. Deeper down, the quartz will consolidate, in all probability, into a regular vein. Garnets and peroxide of iron occur, but all mixed confusedly with the slate. The black and grey slates are not auriferous, whilst the red, and portions of the white slates, are.

'The present company have driven two good adits, one of which is 400 feet in length, which, by draining a large amount of untouched ore, will enable them to win the contents of the mine for a long time, without any additional expense of consequence for drainage. The gold is said to be worth 95 cents per dwt.'

"On the opposite side of the branch, an immense series of quartz beds comes to the surface, which beds are more or less auriferous, and have even been worked, but with great difficulty, owing to the distance from water. They occupy the crest of a hill of considerable elevation, towards Blue Creek, forming an interesting feature of the landscape. (This ridge is known locally as The Devil's Back-bone, and extends for several miles in a North Easterly direction, W. B. P.)

"On the tributaries of the Creek, a great amount of gravel has been washed, in years past, for gold, and with much success, but these works have been abandoned years since."

Thus far Prof. Tuomey.

I can only confirm what is here stated as to Silver Hill, the work has been carried on in a haphazard way by first one set of miners and then by another. I could not get into the lower works but from what appears on the surface there is sufficient evidence of the wasteful and unscientific methods which were pursued. That there is good ore still at Silver Hill the following assays will show. The samples were taken at random from some old dumps:

No. 1276. Bluish crystalline quarts, carrying pyrite.
Gold......4 9-10 ozs. per ton. }
Silver.....3 7-10 ozs. per ton. } Value per ton $104.98.
No. 1277. Yellowish suary quartz.
Gold .... 4-10 ozs. per ton. }
Silver.....3-10 ozs per ton. } Value per ton $8 56.
No. 1278. Light yellow sugary quartz, gave traces of gold and silver.

No. 1276 represents the ore which is found in the bottom of an 80 ft. shaft, so I was informed by Mr. Isham Worsham, who worked at Silver Hill many years ago. Of course it can not be said that all the ore is of this quality, I am even disposed to think that but little of it is so good. Mr. Worsham described the vein as being about five feet in width and as carrying a good deal of sulphuret. The shaft was entirely filled with water at the time of my visit in August, 1891. I have some interesting letters concerning Silver Hill from Major C. H. Parmalee, Ass't. Treas. of the White Breast Fuel Co., 18 Broadway, N. Y. As they contain some valuable information regarding the value of the ore, I reproduce them here, omitting such parts as are of a purely personal nature.

Copy.

WHITE BREAST FUEL CO.,
18 BROADWAY, N. Y.,
Sep't 1st, 1891.

Mr. W. B. Phillips, Univ. Ala.

DEAR SIR: Your very kind favor of the 27th Aug. received, also the report of the Thies Process of treating low grade gold ores, for which I thank you very much.

"Before the War," Prof. Emmons, State Geologist of

N. C., made an examination for me of the Silver Hill property. I will hunt it up and send it to you. Mr. R. C. Hills, the Geologist of our Coal Companies, also made a partial examination of Silver Hill and Gregory Hill. I think I have his letter and the results of some assays he made, which I will also send you. (Neither of these reports has come to hand, W. B. P., Feb. 15th, 1892.) Many years ago I had some assays made of Silver Hill ores but can only say that the lowest was $15.00 per ton and highest $500. Some Cincinnati parties a few years ago had assays made of Silver Hill sulphuret ores, and told me that the average was $30.00. I worked from the North end of Gregory Hill (two miles N. E. of Silver Hill, W. B. P.) ten years ago about 1200 tons of the ore, without any selection. It averaged $1.75 per ton. My screens were very coarse, and we knew but little about the business. .... I think that Gregory Hill would average, without selection, $2.00 per ton and at a cost of 50 cents per ton: ample water can be obtained for 20 stamps. say 60 tons per day. I think it would be safe to call the Silver Hill refactory ores $25.00. I once got $14.00 free gold per ton from 8 tons of refuse Silver Hill ore. It was hauled from the surface yard at Silver Hill to the 5 stamp Battery I had near Gregory Hill. Same screens were used. The ore was partially decomposed by weather exposure, say for twenty years. ....

Yours, C. H. P."

In this letter Major Parmelee also says in regard to Hog Mt.: "A Mr. Phillips, a mining engineer, examined Hog Mt. for Burke of New Orleans. He said to me it was a very valuable property because of the cheapness with which it could be worked. His test of the ore ranged from $6.00 to $16.00 per ton."

Copy.

"NEW YORK CLUB,
5TH AVE. AND 35TH ST.,
Oct. 2nd, 1891.

Mr. W. B. Phillips, Univ. Ala.

.... You are probably not aware that there is a shaft sunk about 90 feet down square on to the sulphuret vein—at least 30 feet or more below any of the old works .... It was in this shaft that Prof. Emmons examined the vein. It has been sunk about 20 feet deeper since that time. The old workings will not interfere with this shaft in any way. There is also another shaft on the same vein about 150 feet west of this (what I call No. 1 shaft) that can be cleaned out. The ore from these shafts will assay from $15.00 to $50.00. The vein so far as stripped averaged from 18 to 24 inches. This is very, very hard and so are the walls. ....

I am very truly yours,

C. H. Parmelee."

At Dent Hill, half a mile north-east of Silver Hill, some work has been done on a curious mixture of talcose schist and quartz, but I was unable to find more than $2.06 per ton of gold in the sample taken. At this point begins the Devil's Back-bone, previously spoken of, and continues for several miles in a northeasterly direction. It is a very bold out crop of a sandy, friable quartz, almost like a sandstone, varying in width from six to fifty feet, and carrying some gold. From Silver Hill to a point opposite the Gregory Hill in Sec. 33, T. 21, R. 22, I took 8 samples but found no more than $2.06 of gold per ton in any on them. All showed this amount of metal. Seven of the samples were taken between Dent Hill and Farrar's Mill along the outcrop, the other one from a point on the ridge directly opposite Gregory Hill, where the wagon road crosses the vein. This tremendous out-crop of quartz is one of the prominent features of the landscape, as already remarked by Prof. Tuomey, and is remarkably uniform for miles. I was along it for about five miles and observed that at no place did it appear to show any deviation from its typical character. It is in most places stained of a light yellowish color, and, on crushing and panning leaves traces of undecomposed pyrite and black iron sand. It has occurred to me that the presence of gold in the highly graphitic schists of Gregory Hill and Blue Hill may be due to leaching from this enormous mass of quartz, the strike and dip of the two being nearly the same. These schists are in places very rich in free gold but do not yet evince the presence of pyrite; the gold is coarse and free. A fuller description of Gregory Hill and Blue Hill will enable one to see the force of this suggestion. The entire locality is brim full of interest to the geologist and to the practical miner, to the first on account of the association of gold with schists heavily charged with graphite, and to the latter on account of the ease with which mining can be carried on here.

GREGORY HILL: BLUE HILL.

Location, Sec. 33, T. 21, R. 22, Tallapoosa County. The ore here is a mass of highly graphitic schist holding numerous small seams of quartz. It is readily mined and easily crushed or stamped. I took two samples of twenty-five pounds each, from the top of the hill, mixed them well and the sample then gave

Gold......3-10 oz. per ton }
Silver.....1-10 oz. per ton } Value per ton, $6.30.

A good deal of work has been done here at one time or another. Major Parmelee has a fifteen stamp mill at work and as the ore is readily treated the stamps weigh 450 pounds each. There is not sufficient water for more than twenty stamps within a mile of the mill. I do not know what the ore yields in the mill. It seems to me that Rolls would do better work on this class of ore than stamps. There is sufficient ore in sight to warrant much more extensive works and I belive that with good management a handsome profit could be secured.

The same ore shows also a Blue Hill in the same Section. A sample taken from the mass gave

Gold......4-10 oz. per ton }
Silver.....2-10 oz. per ton } Value per ton, $8.46.

I panned several pans from Gregory Hill and from Blue Hill and each one gave coarse gold. At Gregory Hill it is almost impossible to take a pan from any place on the top of the hill, where the ore has been mined, without getting free gold, the surface earth yields good panning and when one takes the ore itself extraordinary results are obtained. I have never seen better panning anwhere than from this locality. I do not think that the operations at present conducted there are based on sound principles of mining or of milling. From the methods used there must be a considerable loss which could be avoided by a better system.

I was much pleased with the ore at Gregory Hill; while it may not run over $6.00 per ton yet it can be mined and milled at a slight expense. The chief item will be the water. There may be enough for fifteen or twenty stamps during a favorable season, but during "a dry spell" the supply becomes scarce and uncertain. But little work has been done at Blue Hill yet the general character of the ore is the same as at Gregory Hill. The neighboring ravines have been prospected and some of them washed for gold during wet weather, and I was informed by Mr. Isham Worsham, an old miner of these parts, that he had often gotten good results from the gravel. Gravel washing, however, owing to the scarcity of water, is not to be considered either at Gregory Hill or at Blue Hill, unless indeed the waters of Blue Creek be called into use by means of powerful pumping machinery. This is a bold stream of water and could be tapped at a distance of about one mile. For twenty or thirty feet in depth the ore at Gregory Hill could be easily disintegrated by the hydraulic process, and if it should be proved by experience that stamps do not suit the ore I know of nothing better than the treatment referred to.

Other localities in Tallapoosa County have been the seat of old mining operations, or, rather of gold washing, as for instance the Long Branch about one mile south of Silver Hill, where a great deal of work has been done, with good results. The Owl Hollow, in the same vicinity, is also another famous place for gold gravel. The Long Branch is, next to Silver Hill, the most famous place in this part of the county, as tradition informs us that it yielded much gold forty and fifty years ago. I was unfortunately prevented from visiting it, nor did I see the Owl Hollow. I am informed by old miners that the cream of the gravel in both places has long since been removed.

At the Bonner–Terrell Mine, about ten miles north-east of Dadeville, some work has been done, but I could not visit it and hence have no assays of the ore and know nothing about it except that it is said some of the ore was very good.

Near Perry's old mill on the Tallapoosa River, not far from Dudleyville, according to Tuomey, is the Morgan Mine. He says (Report of 1858, p. 64): "This is situated on a branch very near the river. It is a deposit mine, composed of a thick bed of coarse gravel. Some veins in the neighboring rocks appear to be auriferous. The mine was just opened at the time of my visit and was attracting much attention."

The south-western corner of Tallapoosa County below the Long Branch, is the southern limit of the gold region of the State. It is said that a little placer mining has been carried on in the north-western part of Elmore where it adjoins Tallapoosa County, but I have been unable to find any reliable evidence that it was more than a mere prospecting.

Chambers County, also, belongs to the Lower Gold Belt, but so far as is known no gold mining has been attempted within its borders. Heavy quartz seams are found in the county as far south as LaFayette, but they have not been examined. It is very likely that the northern portion of the county is penetrated by some of the seams belonging to the Goldville Belt. Investigations on this point will be undertaken during the summer of 1892 and the results will appear in the next report. Two complete sections across the gold fields will also be incorporated in the Report on the Upper Gold Belt as it was thought best to defer this until the lines could be run to the Alabama–Georgia boundary.

It is likely that the outlook in the Upper Belt is better than in the Lower Belt, particularly in the vicinity of Arbacoochee, where placer mining has been carried on for fifty years, and Bell's Mills, Idaho, Extension Mine, Pinetucky (where a ten-stamp mill is now at work), and other localities in Cleburne, Randolph, Talladega and Clay Counties. The survey to be undertaken this summer (1892) will cover these localities.

APPENDIX A.

[TRANSACTIONS OF THE AMERICAN INSTITUTE OF MINING ENGINEERS.]

N. Y. MEETING, Sept., 1890.

THE THIES PROCESS OF TREATING LOW-GRADE AURIFEROUS SULPHIDES AT THE HAILE GOLD MINE, LANCASTER COUNTY, SOUTH CAROLINA.

BY A. THIES, CONCORD, N. C., AND WM. B. PHILLIPS, UNIVERSITY OF ALABAMA, TUSKALOOSA, ALA.

1. *Introductory Remarks.*—The Haile Gold Mine is in Lancaster county, South Carolina, 3½ miles east of Kershaw station on the Charleston, Cincinnati and Chicago Railway. It was first opened about the year 1832, and since that time has passed through various fortunes. Many different operations have been practiced here for extracting gold: panning, grinding in Chilian mills or arrastras, stamping, the Designolle process, dry crushing, and finally the Thies process of barrel-chlorination, which has now been in successful use for 2½ years, and by which 36,000 tons of ore have been treated profitably.

The Thies process is in brief the treatment of dead-roasted auriferous concentrates (pyrite, sometimes also chalcopyrite, as at the Phœnix mine, Cabarrus Co., N. C.), with nascent chlorine, without artificial pressure or exhaust, in lead-lined iron cylinders; the throwing of the mass on a sand filter; and the quick filtration and precipitation of the gold chloride with fresh and active ferrous sulphate. The gold is precipitated as metallic gold of a reddish-brown color which, after being allowed to settle completely, is collected, washed, dryed and melted with soda and borax in graphite pots and cast into bars.

The efficiency and economy of the process are such that, in working on a large scale, crude ore of the assay-value of $4 per ton, carrying about one-third of its gold free and two-thirds in sulphurets, can be profitably treated. At the Haile mine 36,000 tons of such ore have been successfully treated, and it is now mined and treated at the rate of 80 tons per day of 24 hours.

It should be observed at the outset that the chlorination system here used is not patented. Any one is free to employ it; and therefore what is said of it in the present paper is without any bias of commercial interest. It is the second attempt to introduce into the southern gold-fields, on a large scale, the chlorination of roasted ore in place of amalgamation, and as an adjunct to amalgamation before roasting.

The uniform and most gratifying success attending the use of this process for several years at the Phœnix mine, Cabarrus Co., N. C., (see TRANS. xvii., 313) induced the owners of the Haile property to introduce it at these mines under the personal supervision of Mr. A. Thies. Mr. Thies' improvements on the old Mears chlorination process have been fully set forth in the paper above referred to. Without severing his connection with the Phœnix Co., he took charge of the Haile mine in January, 1888, where he operated 20 stamps from that time to January last, and since the latter date, has added 40 stamps, making a present total of 60 in operation.

By this process of chlorination there have been treated since 1880 at the Phœnix mine 5,000 tons of concentrates, and at the Haile, since May, 1888, the date of the beginning of the work here, 2353 tons.

This statement is sufficient evidence that the process is conducted upon a commercial scale, and has long since passed the experimental stage. There is now no more reason to doubt its success as applied to low-grade auriferous sulphides than to doubt the success of the Thomas process in the manufacture of steel. Nor is it too much to claim for it that it stands metallurgically towards the other and older processes for the extraction of gold as the Thomas process stands towards the other and older processes for the manufacture of steel. Both these processes were successfully applied about the same time. They are vital improvements upon the ideas of previous unsuccessful applications; and they deal with materials that hitherto had baffled all attempts at utilization, the one with high-phosphorus iron-ores, and the other with low-grade sulphuret gold-ores.

In order to realize the especial significance of the Theis process to the metallurgy of gold, it is only necessary to recall the history of southern gold mines for the past fifty years. It is a history of disappointed hopes. The capital invested in such mines has been, to say the least, extremely unproductive. Even during the last six or eight years, when any one who chose might have ascertained for himself the true method of treating these ores, the old state of affairs has continued, and the old story has repeated itself.

The elements combined in this successful solution of the problem are concentration, roasting and chlorination. They go hand in hand; each is incomplete without the others. But what distinguishes this process from all others is the method of applying the chlorine to the roasted ore, of which we shall speak later.

Since a complete account of the process requires some notice of the conditions under which it is employed at the Haile mine, this paper will briefly describe the geological occurrence of the ore; the operation of mining and transportation to the mills; and the milling and concentrating; after which an account will be given of the roasting and chlorination, including the delivery of the gold-solution to the precipitating-vats, and finally, the precipitation, collection and smelting of the gold.

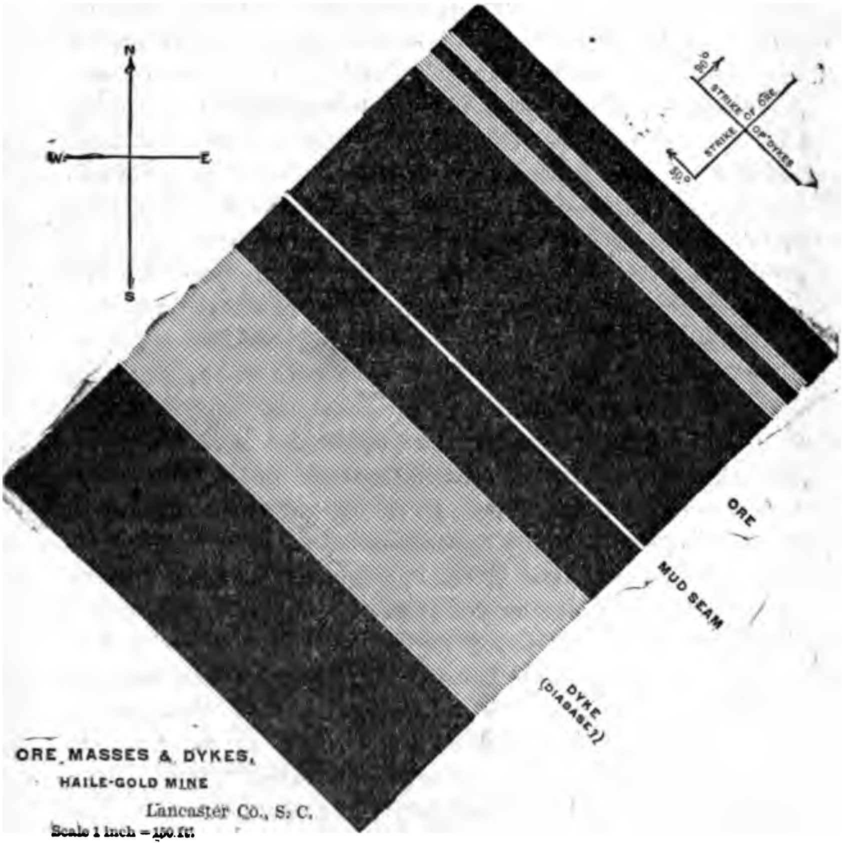
2. *Geological Occurrence of the Ore.*—For a more detailed description of the geological conditions, the paper of Messrs. Thies and Mezger, which is presented simultaneously with this. may be consulted, and reference may be conveniently made to the geological sketch-map by Mr. Mezger, which accompanies that paper. It is not intended here either to controvert or fully to adopt the conclusions there set forth, the simple reason being that the two papers have been

prepared independently, and there has been no subsequent consultation of all the writers concerned.

The ore at the Haile mines is a mixture of pyrite and stratified talcose slate. The strike of the strata varies from N. 52° E. to N. 73° E., and the dip (nortwesterly) from 45° to 75°. The foot-wall is soft talcose slate, colored yellowish, brownish and red by iron-salts, and showing cross-joints. The hanging-wall is (often if not always) greenstone. From the foot-wall towards the hanging wall there is a well-marked increase in the hardness of the ore; bands of siliceous matter appear, and veinlets and veins of almost pure pyrite, from the thickness of ½ inch to 1½ foot. These streaks of pyrite cut across the slates in all directions and are also at times parallel to them. Now and then masses of considerable hardness are also found near the foot-wall, but whether they occur here or in the vicinity of the hanging-walls, they are evidently derived from the talcose slates. It is believed that whatever be the earthy material mixed with the slates in the ore-bearing mass, it has been derived from the slates themselves. Even the very siliceous material found near the hanging-wall and bearing no close resemblance to the slates either in color, hardness or stratification, was doubtless derived from them.

Several dikes, seemingly of diabase, cross the slates at irregular intervals. On the accompanying diagram they are shown as cutting the slates at right angles to their strike. This is not quite true; but the variations are slight. Between these dikes lie the immense deposits of talcose slates, impregnated with gold-bearing pyrite and with more or less free gold. The free gold is generally fine. Wherever the slates are rich enough in free gold and in pyrite, they are mined. The richer streaks are of various widths, from 2 feet to 30 feet, and are of the same general character as the main body of the slates. In immediate proximity to the dikes, as well as to the hanging-walls, the slates are, as a rule (with some exceptions) richer than elsewhere.

As to the correlation between the dikes and the ore-masses, little will be said here. That the dikes do influence the richness of the ore favorably seems to be beyond question, but it is not so easy to say why. Nor can we speak positively as to the nature of the dikes themselves. They stand nearly vertical; they cut the strike of the slates nearly at right-angles; they exercise a favorable effect upon the richness of the ore; but whether they are strictly diabase or not, and whether they are of plutonic origin or not, will not be discussed here.



ORE MASSES & DYKES,
HAILE-GOLD MINE
Lancaster Co., S. C.
Scale 1 inch = 150 ft.

3. *The Mining and Transportation to the Mills.*—In such thick masses of ore, choice must be made between taking out all the ore (sustaining the walls with timbers) and taking such ore as can be extracted, using as little timber as possible, and leaving pillars. The first plan is not to be thought of here, on account of the varying value of the ore, the enormous amount of timber required and the expense connected with keeping it in sound condition. The other plan was therefore adopted and has worked satisfactorily. The levels are driven from 60 to 70 feet apart and connected at different points by winzes which serve during stoping as ore-shoots. Between these winzes main pillars are left, while the ore is stoped on each side of the pillars from hanging to foot, leaving sufficient solid ore against the hanging-wall to insure safety.

Of the mines partly opened and worked in earlier years, the Bequelin (formerly known as the Blauvelt) is now in active operation. The main shaft has reached a depth of 194 feet on the dip of the ore, of which 15 feet are used for a sump. The levels are driven east and west from the shaft at intervals of 60 feet, and the ore is trammed from chutes at the 180 foot level to the main station to be hoisted by double skips to the surface. From 80 to 100 tons are hoisted in 24 hours.

The system of mining would require for its full discussion a separate paper. It may be characterized here as the pillar-system (Pfeilerbau) generally employed when excessive timbering is to be avoided.

The drilling is done by double-hand, single hand and machine-drills. For this latter purpose there are 4 Ingersoll-Sargeant Drills of 3½-inch cylinder, now used entirely for development-work.

The plant at the Bequelin shaft consists of 2 boilers, of 90 and 35 horse-power respectively, which, under full headway, carry from 75 to 80 lbs. steam pressure, consume about 6 cords of pine wood in 24 hours (at a cost of $1.40 per cord, delivered), and furnish steam to one 20x30 Ingersoll air-compressor, one 40 horse-power Dickson reversible link-motion hoisting engine, one 20 horse-power crusher-engine for a 20x10 Blake crusher, and one No. 9 Davidson mining pump, of 200 gallons per minute capacity. The ore is hoisted in skips which discharge automatically upon two grizzlies and thence to the crusher. One man can load 60 tons per ten hours on the skips, which hold 1500 lbs. each.

The grizzlies have each a square surface of 32 feet, and the bars are set 1½ inches apart for the "shaft-smalls," while the coarser ore goes directly to the 20x10 crusher. The grizzlies and crusher discharge into an ore-bin, holding 30 tons. From this bin the ore is hauled by a narrow-gauge locomotive ¾ mile to the mill; a trainload being 7 cars carrying 3 tons each. An engine-driver and two boys look after the loading of the ore from the bin on to the cars, the transportation to the mill and the discharging into the mill-bins. They also keep the track in repair.

4. *Milling and Concentrating.*—There are at present 40 stamps working; 20 more are up, but not quite ready to begin dropping. The average amount of ore crushed per stamp per 24 hours during the last 4 months is 2.01 tons. The stamps weigh 750 lbs. each, and drop 5¼ inches 84 times per minute. The screens are 36-mesh, of brass wire. Formerly 40-mesh slotted Russian sheet-screens were used, but these were discarded in favor of the wire-screens, the latter not only possessing greater durability, but giving a far more uniform pulp for concentration. The average life of the wire-screen has been 6 weeks, while slot-screens often had to be thrown out in 14 days. The average amount of water used per stamp is 3½ gallons per minute, and the average consumption of quicksilver per ton of ore is 0.35 ounces. The average wear and tear of shoes and dies per ton of ore stamped is 1.3 pound.

The area of inside-plates per battery of 5 stamps is 1.75 square feet, and of outside-plates 32 square feet, with a 2-inch inclination to the foot. There are 3 boilers of 50 horse-power each and one Harris-Corliss engine of 150 horse-power. The 40 stamps are run with a steam-pressure of 50 pounds.

The mill is of the back-to-back type, 30 stamps on east and 30 stamps on west side. Each double battery has its own cam-shaft, which is driven by belt from a pulley on the shaft common to all the stamps on the same side. The east battery-shaft and the west battery-shaft are driven by steel bevel-gearing from the main shaft.

The railway-cars are bottom-dumpers, and discharge their ore on the iron-plated comb, dividing the east-side bin from the west-side bin. These bins hold 150 tons each, and discharge their ore into Hendy self-feeders. The angle of inclination of the bin-bottom towards the self-feeders is 60°. The battery-tailings are conveyed to the concentrator through open launders 8x10 inches, with cross riffles, one inch high, every 8 to 10 inches. Total length of launders, 78 feet; inclination, ½ inch per foot. The launders discharge into a box from which runs a series of small launders at right angles to the main launder, to each concentrator. There are 16 Embrey end shake concentrators, 8 to each 20 stamps. The distribution table for the battery-tailings is provided with an amalgamated copper plate for saving any free gold, amalgam or free quicksilver which may escape from the outside battery-plates. The belts are set with 2⅝ inch inclination and travel 5 feet per minute. The number of strokes is 192 per minute. The yield in concentrates per ton of ore stamped averages 9 per cent., *i. e.*, for each 11 1·9 tons stamped, there is a yield of 1 ton of concentrates. The loss in sulphurets is about 10 per cent.

The fire-assay value of the ore delivered to the stamp is $4.50 per ton. The mint-returns of bullion give $3.90 per ton of ore treated, of which $1.45 is to be credited to the stamps, *i. e.*, to free gold, and $2.45 to sulphurets. Taking the value of the ore at $4.50, and the actual yield in bullion at $3.90, we have an indicated loss of 60 cents per ton, or 13⅓ per cent. Taking the yield in free gold at $1.45 per ton from an ore worth $4 50 per ton (or approximately 32 per cent.), we have 68 per cent. to be sent into the concentrates. But the total yield in free gold and in gold from the sulphurets is $3.90 per ton, so that the ratio of the free gold saved to the total amount saved is approximately 38 per cent., and of the combined gold 62 per cent. An ore of this kind therefore carries about one-third of its gold free and about two thirds combined.

We have used the term combined gold to express the condition of the gold that is not free. Whether the gold that is not free is chemically or mechanically diffused in the sulphurets. or both, is not known. Much has been written upon this subject; but as yet we are not warranted in adhering positively to either view. One thing appears certain, viz.: that, no matter what may be the state of the gold in such material, it must be thoroughly roasted before it can be profitably extracted. From the 80 tons of ore stamped per 24 hours, there are obtained 7½ tons of concentrates, which gives as the yield of each concentrator, a little less than one-half ton. The concentrates are piled in a shed and thence conveyed by rail to the furnaces, a distance of 1200 feet. The average assay-value of the raw concentrates has been, for the last 12 months, $30 per ton. This corresponds closely to the estimated value. Assays vary from $25 to $35 per ton of 2000 pounds. The percentage of sulphur in the raw concentrates varies from 40 to 45 per cent. In roasting, this is brought down to from 0.25 to 0 40 per cent. and the value of the material per ton is increased by one-third, *i. e.*, a raw concentrate of $30, becomes a roasted material of $40 per ton.

5. *Roasting and Chlorinating.*—The roasting-plant consists of one pan revolving furnace (of the type described in the paper by one of the writers previously referred to, ***Trans.*** xvii., 313), two double-hearth reverberatories, each of 400 square feet roasting-surface, and one American Spence furnace.

The capacity of the pan-furnace for twenty-four hours is 2½ tons of roasted ore (equal to 3¼ tons of raw concentrates) and that of each reverberatory furnace 2 tons of roasted ore (equal to 2⅝ tons of raw concentrates). The yield of roasted ore per day of twenty-four hours is 6½ tons from one pan and two reverberatories. The consumption of wood is one-half cord for each furnace per ton of roasted ore. Each furnace is attended by four men for twenty-four hours, who do all the work of charging, firing and rabbling, and also deliver the roasted ore on the cooling floor. They are paid $1.00 per day of twelve hours. The wood used is pine and costs $1.40 per cord delivered. Mr. Spilsbury, in a paper read before the Institute in 1883, (*Trans.* xii., 103) puts the roasting-capacity of the reverberatory furnace at 6 to 10 tons per day of twenty-four hours. This is not practicable when the product is to be so roasted as to be suitable for chlorination. No such feat has been accomplished in *that kind* of roasting by any furnace, modern or ancient, automatic or otherwise. It should be added that the roasting to which Mr. Spilsbury refers was followed by amalgamation.

In November, 1889, an American Spence furnace was built, but the expectations entertained concerning its operation were not realized, and the furnace, after many unsatisfactory attempts, has been idle since. The difficulties encountered were: 1st, the matting of the iron rakes whereby they were prevented from swinging on their axis; and 2d, the banking of the ore on both ends of the shelves.

The first difficulty, viz., the clogging of the rakes by the fine ore, was in part overcome by providing the rake with a sheet-iron hood. But although this gave some help, it did not altogether remove the trouble. The swinging of the rakes on their axis is a *sine qua non* of their efficiency, and just in the measure in which this is prevented, in the same measure is the roasting hindered. If the rakes cannot swing they cannot rabble the ore, and without this no thorough roasting is possible. This trouble is intimately connected with the second difficulty, viz , the banking of the ore at the ends of the shelves.

Under the present construction of the furnace the difference between the length of the roads which move the rakes is 6 inches, so that when the ore drops from a shelf to the one underneath, the rake on the lower shelf is 6 inches in advance of the rake on the upper. This distance is not sufficient to prevent the fine, red-hot ores from falling upon the lower rake as they are discharged from the upper shelf. These ores move very easily—they may almost be said to flow; and they begin to fall through the opening when the rake is 12 to 14 inches from it. In this way the ore falls in front and on top of the lower rake, and is pushed by it towards the end of the shelf. In its back-stroke, the rake, being clogged by the fine ore falling on it, cannot take with it all of the ore that it pushed forward. Some is left, and the pile grows larger and larger, until finally the entire end of the shelf is full of ore. The alternate pushing and pulling of the clogged rakes causes a banking of the ore at both ends of the shelves. After several weeks of continual trouble and worry it was finally decided to discontinue the attempt to utilize this furnace for chlorination-roasting.

The principle on which the Spence furnace works is correct in every detail, and it is undoubtedly the proper furnace for roasting coarse ores for smelting purposes where a complete elimination of the sulphur is not wanted. A chlorination-roast, however, must be a uniform dead-roast, and no furnace which will not deliver material in that condition can be used.

From the furnaces the ore goes to the cooling floor where it is allowed to cool; then it is dampened with water and elevated to the chlorination-floor.

The chlorination-plant consists of two chlorinators, eight filters, two storage-tanks for the filtered solutions, thirteen precipitating tanks, two settling-tanks for precipitates, a storage-tank for sulphuric acid, and a tank for preparing the ferrous sulphate (copperas).

As regards the chlorination, no better description of what is now done at the Haile can be written than is contained in a letter from Mr. Thies to Mr. C. N. Aaron, published in the Eighth Annual Report the State Mineralogist of California, 1888, pp. 844–846.

Mr. Thies says:

PHŒNIX MINES, OCTOBER 15, 1888.

C. N. AARON, ESQ., SAN FRANCISCO, CAL.

Dear Sir: In my former letter I promised to write an article on the "Hydrometallurgy" of gold, but seeing, through the pressure of business, that it will be impossible for me to do justice to the subject to get it ready for print by the 1st of November, I will here give you a brief description of the barrel-chlorination as in practice at the Phœnix mines, North Carolina, and the Haile gold-mine, South Carolina.

The success of barrel-chlorination I attribute to the generation of chlorine in the ore-pulp, to attrition and to quick filtering. The original Mears process was based upon the presence of chlorine, either generated outside and forced by a pump into a lead-lined cylinder through a hollow trunnion or generated by the use of chloride of lime and sulphuric acid in such quantities as would create a pressure of from 30 to 40 pounds per inch. To ascertain the pressure, a lead-lined gas-pipe in the form of a goose-neck (and called so), passed through the hollow trunnion, was securely fastened, provided with a stuffing-box and connected with a pressure-gauge. In using chloride of lime, the inner lead-lining of the cylinder was provided with a sulphuric acid chamber capable of holding 100 pounds of acid. While, indeed, the result in working well-roasted ores was satisfactory, the annoyance through leakage; the continual wearing out of goose-neck; the collapsing of the inner lead-lining by a too strong exhausting of the gas; by being too often deceived as to the presence of chlorine, when pressure but no chlorine was present, causing rehandling of the ore, made the process an expensive and unsatisfactory one.

In this annoying way I worked for nearly two years, testing meanwhile the effect of a highly saturated chlorine-water under attrition without pressure, and when, after repeated tests, I found my results equally as good without pressure as with the highest pressure (and better when I divided the requisite amount of chlorine and sulphuric acid, so as to have the nascent gas during the time of working), I remodelled the chlorinator by closing up the hollow trunnion and removing the goose-neck and acid-chamber and substituted a lead valve, connected with the inner lead-lining in such a way that the presence of free chlorine can be ascertained at any moment, and no charge subject to chlorination need be thrown on the filter without full knowledge of the work being complete.

The cast or sheet-iron cylinder (chlorinator) is 42 inches in diameter by 60 inches long. The heads are cast and securely bolted to end-flanges and provided with tight and loose pulleys. The bung for the introduction of the roasted ore and chemicals, 6 inches in diameter, is provided with a lead-lined cover, which, before rotation, must be closed hermetically.

The interior of the cylinder is lined with sheet-lead of 10 to 12 pounds per square foot. The capacity of the chlorinator is from 1 to 1¼ tons of roasted ore. Before introducing the ore, the chlorinator is charged with from 100 to 125 gallons of water, or, I might say, with enough water to make an easy-flowing pulp. This done, the roasted ore is introduced, half the requisite quantity of sulphuric acid is then poured in, and lastly, half the required chloride of lime, when the bung-hole is closed and the chlorinator is set in motion at the rate of fifteen revolutions per minute.

For Phœnix ores I used 40 pounds of chloride of lime and 50 pounds of commercial sulphuric acid per ton of roasted ore; but I charge 20 pounds of chloride of lime and 24 pounds of acid first, rotate for three or four hours, open the bung and charge the other half, having found better results in dividing the chemicals. Rotate for two or three hours longer, and if, by the aid of the lead valve, free chlorine is found present the cover is removed from the bung-hole and the chlorinated ore is thrown on a shallow filter, 6 by 8 feet, provided with a 5-inch filter-bed, over which the pulp spreads to a thickness of about 4 inches.

The filter, before the ore-pulp is thrown on it, is first flooded with clear water from below, and when the water stands over the filter the discharge-hole is opened, so that the water acts as a cushion against the ore-pulp, prevents the packing of the filter-bed and admits of a free filtering.

When the chlorinator has been emptied on the filter the cork is removed and the solution allowed to pass into a stock-tank below. As soon as the first solution has passed through, so that the ore-surface is exposed, from 3 to 4 inches of water is added over the whole surface; and when this is filtered through and the ore surface exposed again the whole space above the ore, about 11 inches in depth, is filled, which, by practice on Phœnix ore, has proved sufficient to remove all the chloride of gold; but should there be still a reaction with ferrous sulphate more water must be added.

The filters are lead-lined, 18 inches deep, and have a fall of 1 inch towards the outflow. The bottom is first covered with perforated glazed tiles or clays or mineraline, which is impervious to the action of acids and chlorine. On this rests the gravel filter-bed, which is topped off with ordinary clean river sand. To prevent the filter from getting an uneven surface, longitudinal 1¼ inch wooden slats, 8 or 10 inches apart, keep it in place.

The filtering should be accomplished as quickly as possible, but, as this depends generally on the fineness of the ore treated, no rule can be established. As long as the solution shows the presence of chlorine when the last wash-water has passed through the filter, there is no danger of not having clean tailings. The solutions accumulating in stock-tank are let off into smaller tanks for precipitation with ferrous sulphate, which should always be regenerated, if not active, so as to destroy any ferric sulphate. Care should be taken by examining, after twenty-four hours, to ascertain if all the gold had been precipitated, as losses have occurred by a partial precipitation. The tanks for precipitation should not be too deep; a convenient size is 6 to 8 feet in diameter and 3 feet high, holding the solutions from about 3 tons of roasted ore. A sufficient number should be on hand to allow the precipitate at least three days to settle. After three days settling in shallow vats, the supernatant liquor can be drawn off and fresh solutions added for precipitation.

At the Phœnix, the liquor is passed over metallic iron, and the copper is recovered as cement. From the precipitating-tanks the precipitate is finally collected, washed as clean as possible to remove the iron-salts, dried and melted.

The amount of chloride of lime and acid used at the Phœnix I have stated as 40 and 50 pounds respectively, which is due to the presence of an appreciable amount of chalcopyrite. An excess of acid should always be used so as to convert all the lime into a sulphate to remain in the filter. The solution should be slightly acid. If neutral, soluble chloride of lime will cause a bulky precipitate with ferrous sulphate. At the Haile mine, where I have to deal with a pure "iron sulphuret," I use at present but 10 pounds of chloride of lime to 15 pounds of acid, and treat 4 tons of roasted ore in two chlorinators during ten hours, and I have not failed to extract 94 per cent of the assay-value.

The Haile mine ores, which have been so long the bugbear for economic treatment, and on which so many experiments have failed, are offering no obstacles to the barrel-chlorination, and are cheaper and easier to chlorinate than the Phœnix ores.

As the success of chlorination, by whatever process, depends on a thorough roast, assuming that we have clean concentrates, it is of the utmost importance that the roaster should have some guide to go by, and to this end, I let him test every charge before drawing by a bright-filed iron-rod. A small portion of the roasted ore is boiled in water and stirred with the bright iron. The least trace of sulphates will stain the iron,—a sign for the workmen that the roasting is not completed.

At the Phœnix, I use a revolving pan furnace of 12 feet diameter, with a short reverberatory attached. From two working doors the roaster can rabble the ore. When a charge is finished, the ore is discharged through the hollow axis on which the pan revolves into an outer circle below, and is then removed by scrapers attached to the bottom of the pan into a car, and delivered to the cooling-floor, from which it is elevated into the chlorination house. Such a pan furnace roasts 1 ton of raw ore in twelve hours, with a consumption of three-eights of a cord of wood and 90 cents for labor. The power necessary to drive the pan is a small item, and will not exceed 25 cents per ton of raw ore.

At the Haile mine, a double reverberatory furnace furnished 2 tons of ore every twenty-four hours, with an average consumption of 1 cord of wood at $1.25 per cord and four laborers. The cost per ton of roasted ore amounts to $2.62½.

The cost of chlorination by the barrel process depends chiefly on the number of tons chlorinated per day. Two men can easily chlorinate 4 tons in ten hours, elevate the ore and clean out the filters, of which I have four to each chlorinator; and having arranged on this basis the work at the Haile mine, the cost for chlorinating 4 tons daily is as follows :

40 pounds of chloride of lime at 3 cents	$1.20
60 pounds of sulphuric acid at 2 cents	1.20
2 barrels at 90 cents	1.80
1 chlorinator man	2.00
Motive power	.50
Total	$6.70

or $1.67½ per ton.

Add to this 12½ cents for sulphuric acid for making sulphate of iron, and 20 cents for repairs and wear, which is more than liberal, and we have the sum of $2 per ton for chlorination, or $4.62½. for roasting and chlorinating 1 ton of roasted ore, representing 1½ tons of raw iron pyrites. Inside of seven hours from the time the ore is in the chlorinator, the solutions are ready for precipitation and the tailings are clean.

The wear on the inner lead-lining of the chlorinators is imperceptible,—a chlorinator in use at the Phœnix for over five years does not show any wear on the lead.

That the barrel chlorination has advantage over the Plattner process can not be gainsaid, and its successful working here and at the Bunker Hill, Amador county, California, where it surpassed the Plattner in results, will undoubtedly lead to its adoption in regions where the auriferous sulphurets are an important factor in the production of gold.

Hoping that these notes will aid you in your work, and ready to give any desired information,

I remain very truly yours,

A. Thies.

This description is as true of the Haile to-day as it was two years ago. The amount of chemicals varies between 10 and 15 pounds for chloride of lime and 15 and 20 pounds for sulphuric acid. The assay-value of the tailings from the chlorinator, which are removed from the filter-bed and thrown over the dump, is, on an average, $2 per ton.

6. *Precipitation, Collection and Smelting of the Gold.* The ferrous sulphate employed as a precipitant should be used fresh, and to this end it is made up fresh for each day's run. It is easily prepared from one day to another.

As already observed, care must be taken to see that the precipitation is complete by testing the solutions about twenty-four hours after precipitation. Generally, the total absence of chlorine and a sweetish odor are fair indications of a complete precipitation after a thorough stirring with ferrous sulphate.

At the end of a month's work, or whenever it is deemed necessary, the completely-settled precipitate is taken up from the precipitating-vats into small lead-lined tanks 2 feet by 4 feet in size and 2 feet deep, in which it is allowed to settle again for twenty-four hours. The supernatant liquor is then syphoned out, and the precipitate is washed with boiling water until freed from most of the iron salts. It is then collected on filters, dried and melted in Dixon crucibles with borax and soda, and shipped to the United States Assay Office at Charlotte, N. C. Its fineness varies between 975 and 985.

The successful treatment of 2,353 tons of concentrates from the Haile mine by this process is all the more gratifying because of the failure of all other processes here to work at a profit.

It is commended to those who have to deal with large quantities of low-grade sulphurets in the belief that it will solve their difficulties, and enable them to work such ores profitably. For simplicity, cheapness and adaptability to such ores, it cannot be too highly praised.

(At this time, February, 1892, there are 60 stamps running at the Haile, and the process, under the skillful management of Mr. Thies, continues to justify the expectations based upon it. I can heartily commend it to all who have low grade sulphuret ores to treat. W. B. P.)

APPENDIX B.

METAMORPHIC ROCKS OF COOSA, TUOMEY'S REPORT OF 1858, pp. 43 TO 47.

It was stated in a previous report that the metamorphic rocks terminated at Wetumpka. Beds of gneiss, passing into mica slate, occur here in great force. The edges of the strata rise up boldly from the bed of the river, but are covered by drift from the banks. The rock is coarse, splits with ease, but the bedding planes are uneven. The strike is north-east and south-west, and the dip 75° north-west.

Turning east above the Penitentiary, and passing over the undulating surface of the drift, to where the road crosses Coon Creek, below the ford, a ledge of rock is seen, which resembles that of Wetumpka, excepting that it is rendered porphyritic by flattened crystals of pink feldspar, that lie between the laminae of mica. Although coarse, this rock is strong, and the contrast between the color of the feldspar and the black mica gives it an agreeable appearance. The crystals of feldspar are compressed, and interlaced by the mica; the rock may be called a porphyritic gneiss. At this locality another bed of white gneiss occurs. It resembles very much the rock at Tallassee, both in color and compactness, and it would make an excellent building material. Although no quarry is opened, the rock may be examined at the ford. With the exception of the denuded beds of streams, the rest of the country is composed of drift, covered with one unbroken pine barren, to the Tallapoosa.

Above the falls of Tallassee, the river is wide, and divided by little islands, into numerous channels which unite near the barrier of gneiss, which crosses the stream in a direction nearly East and West. The pent up water has forced a passage through this natural dam, and foaming amongst the vast masses of rock, sends its spray to the winds. The gneiss is fine grained, and compact, but not thick bedded. Immediately at the falls the strata are worn into pot-holes, some of which are eight feet in diameter. The water, often pouring into these finds an outlet between the strata, which in time are completely under-mined, and in this way most of the huge masses lying around have been broken off from their original beds. The entire fall, at the Factory at the foot of the falls, is sixty feet. In summer, when the banks are fringed with green and beautiful shrubs, this place presents a scene of picturesque wildness, that will repay the labor of a visit. On the right, the valley is quite narrow, and a well located road, exposes on its side the beds of drift which rise to a height of 200 feet above the river.

It would be difficult to conceive of a more favorable locality for manufactories, on a large scale, than this. The whole of the river is precipitated, through a narrow gorge, over a fall of 60 feet, and in a distance of 8 miles the river falls 800 feet.

The Factory recently erected here, at a cost of $30,000, presents a fine example of the adaptation of the rock of the falls to building purposes.

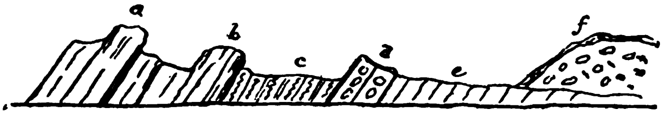
On the side of a little stream, called Slone's Mill Creek, which empties into the river below the falls, the gneiss becomes slaty, and excellent flagging stones could be quarried. Although such materials are found elsewhere in the State, I know of no locality so favorable as this.

The first falls on the river occur two miles South of Tallassee, at the site of the old Indian village of Tuckabatcha. (Pickett's History of Alabama, Vol. I, page 124, gives Took-au-batche-tal-lau-hasse as the name of a town among the Upper Creeks in 1778, W. B. P.)

The river, after following the metamorphic rocks till they are covered to a great depth by the drift, turns directly West to join the Coosa, four or five miles below Wetumpka.

Section from Tallassee, on the bed of the river, to Tuckabatcha:

Fig. 3.



Section from Tallassee to Tuckabatcha. (after Tuomey)

a. Beds of gneiss, forming the Tallassee Falls, strike East and West dip towards the North 40°.

b. Flagging stones finely exposed on Slone's Mill Creek: course of the joints which intersect the quarry, North 20° West.

c. Mica slates.

d. Thick strata of slates with bosses of feldspathic and coarse crystalline granite protruded through them. Rounded masses of quartz are found embedded in the slates, and when the latter are worn away, they rest on the surface like large boulders.

e. Micaceous and talcose slates, containing lentiform nodules of graphite between the slates, which abound in garnets. The graphite, when divested of the slates, is very pure, but unfortunately the pieces in which it may be procured are not very large. The strata extend across the bed of the river, and as the banks are covered with alluvium can only be seen at low water. The locality requires a more thorough examination than I could give it at the time of my visit.

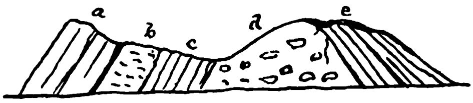
f. Beds of drift.

North of the falls the rocks become talcose, and on a little stream, called Coon Creek, beds of hornblende and soapstone occur. In a hollow, near the creek, a bed of soapstone of great thickness is found. This seems to have been well known to the Indians, who resorted to the spot for the purpose of manufacturing culinary utensils. Excavations, of considerable extent, were made on the best portions of the rock, and the sides of the excavations are curiously pitted where the vessels have been cut out. It appears to have been their practice, to inscribe on the rock the circumference of the pot or bowl to be cut out, and then excavate around it until a sufficient depth was attained, after which the mass was split off and finished. Occasionally, when failure in splitting off the mass ensued, pieces remain attached to the rock. Everywhere the impression of the bottom of the vessel is left on the face of the quarry.

The rock is calcareous, effervescing with acid. Crystals of pyrites are abundant, but no other minerals, excepting actinolite and talc, are found here.

These Indian excavations have deceived many inexperienced persons, who supposed that they were made for the precious metals. The soapstone of this locality extends across the county to Chambers, and at intervals throughout this extent it is perforated by such excavations. This is the locality which excited so much interest at the Tallapoosa Silver Mine.

Figure 4.



Section on Coon Creek (after Tuomey.)

a. Gneissoid rock extending to the mouth of the Creek.
b. Sienitic gneiss, with flat crystals of hornblende.
c. Hornblende slate.
d. Soapstone, 100 feet thick, out-cropping on Penn's land.
e. Hornblende.

The strike on the rocks in this section is South, South-west, and North, North-east, dip of the bed at *e.* South, South-east, and of the gneiss at *a.* North, North-west.

From this point to Silver Hill hornblende slates are every where displayed, with the exception of the occasional occurrence of beds of gneiss, as may be seen on the Sougahatchee, where the rock passes into talcose slates. The course of the rocks here is North-east and South west, dip 40 degrees

North-west. The country is composed of rounded hills, covered with a warm, brown soil, common to hornblende rocks. Such soils suffer from excessive drouth, but for the production of grain they are amongst the very best.

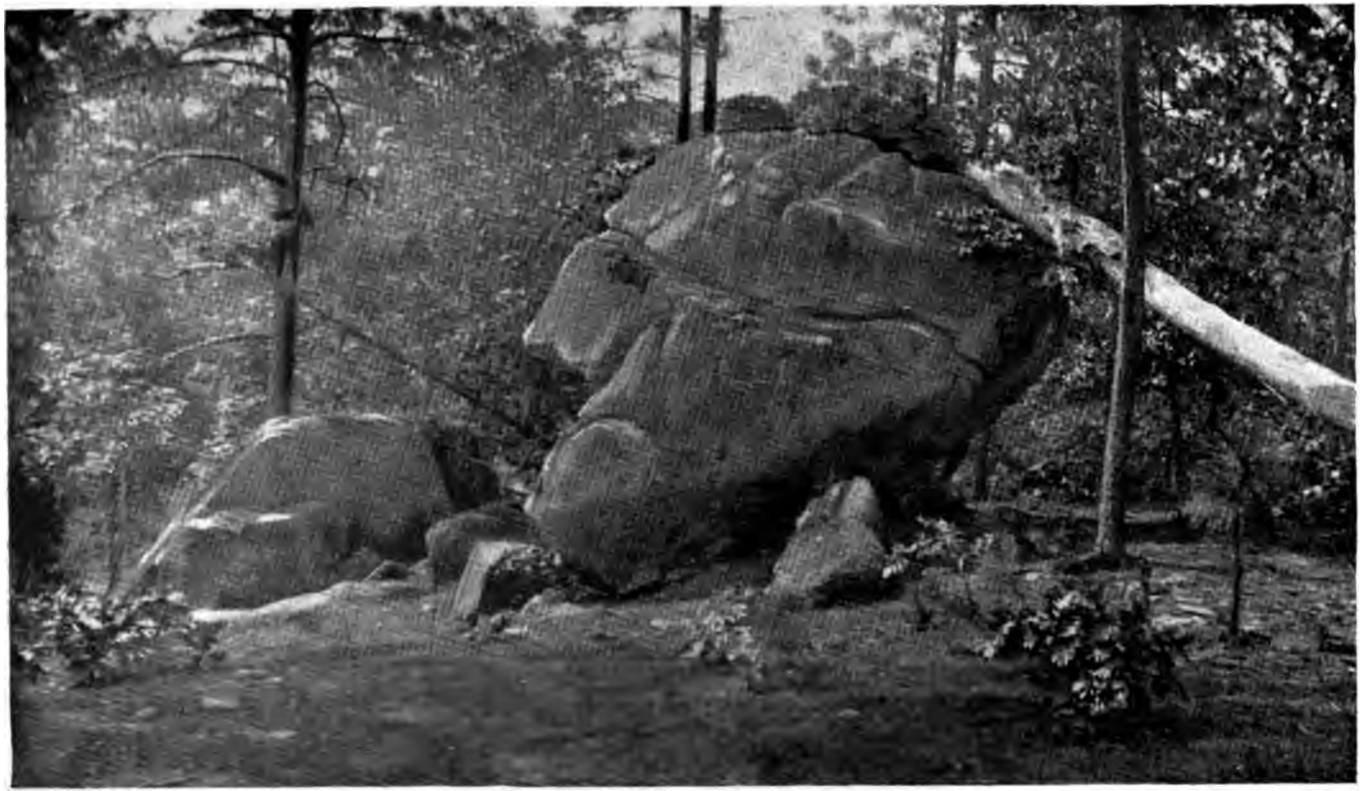
GRANITE OF COOSA AND TALLAPOOSA (pages 77 and 78).

Around Rockford large weathered masses of a whitish gneissoid granite are found on the surface. Sometimes immense fragments are undermined and broken off by their own weight. (Three photographs of such masses are shown herewith, taken by myself during the summer of 1891. W. B. P.)

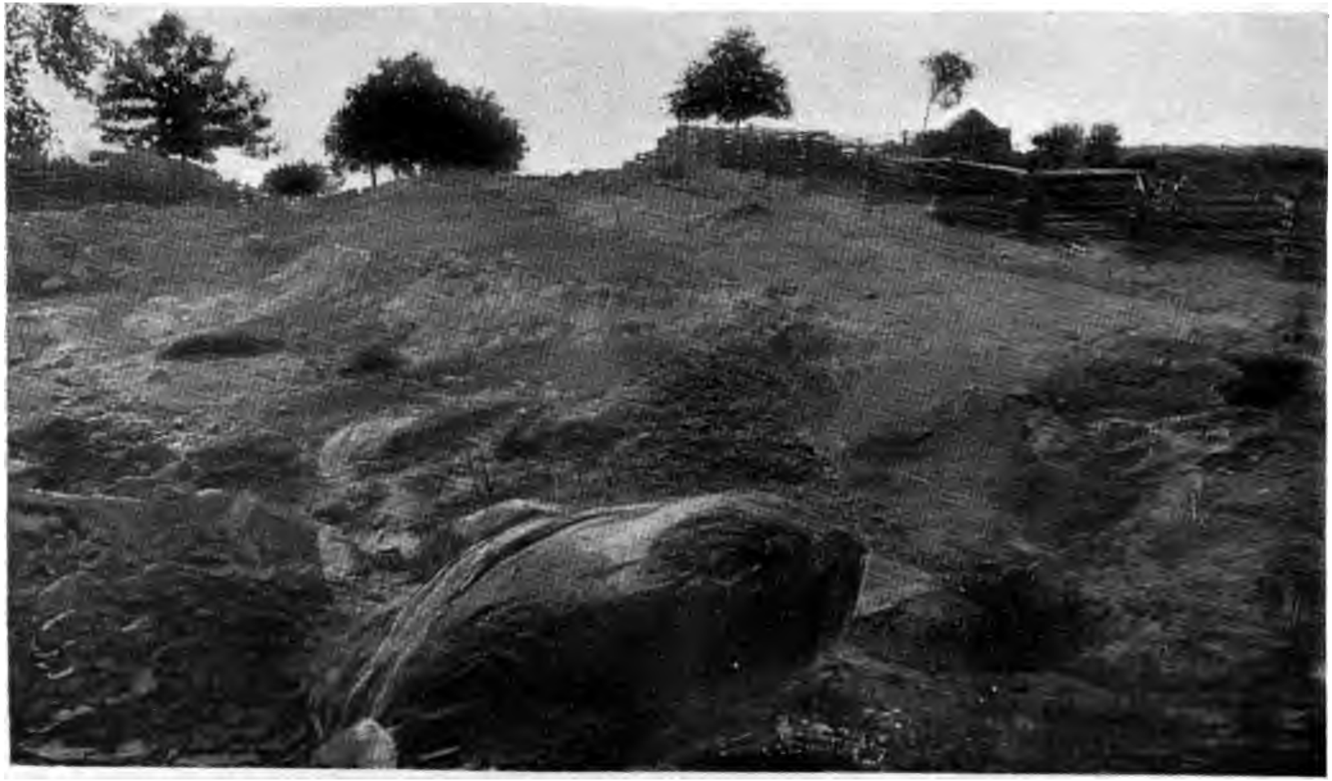
On the way to Bradford I saw another trial shaft, sunk, I believe, in search of silver. There was really no reason to expect any profitable result from exploration here. The shaft was sunk on a bed of coarse slate abounding in rough garnets. It is true, that mica slate containing garnets is a promising metalliferous rock; still we must have some positive evidence of the existence of some valuable metal in the rock before we commence expensive operations. The rock in question contained the merest trace of copper, not more than one might expect to find in any of the rocks of this region.

At Bradford, gneiss is finely exposed at the Factory, where it is cut up into prisms by joints running North 20 degrees East, across the stream; the fall here is thirty-five feet. A mile further up it becomes more granitic, and rises above the surface, in the manner of the masses at Rockford. On the surface it is weathered, sometimes inclined to disintegration, and where it is feldspathic produces a fine porcelain clay; this clay I found excited interest at some of the mines. At Mr. S. S. Graham's the rock is hard, very white, and clings to the hammer. It would be difficult to find a more beautiful building material. It belongs to the great gnessoid granitic belt that extends along the northern portion of the Southern States.

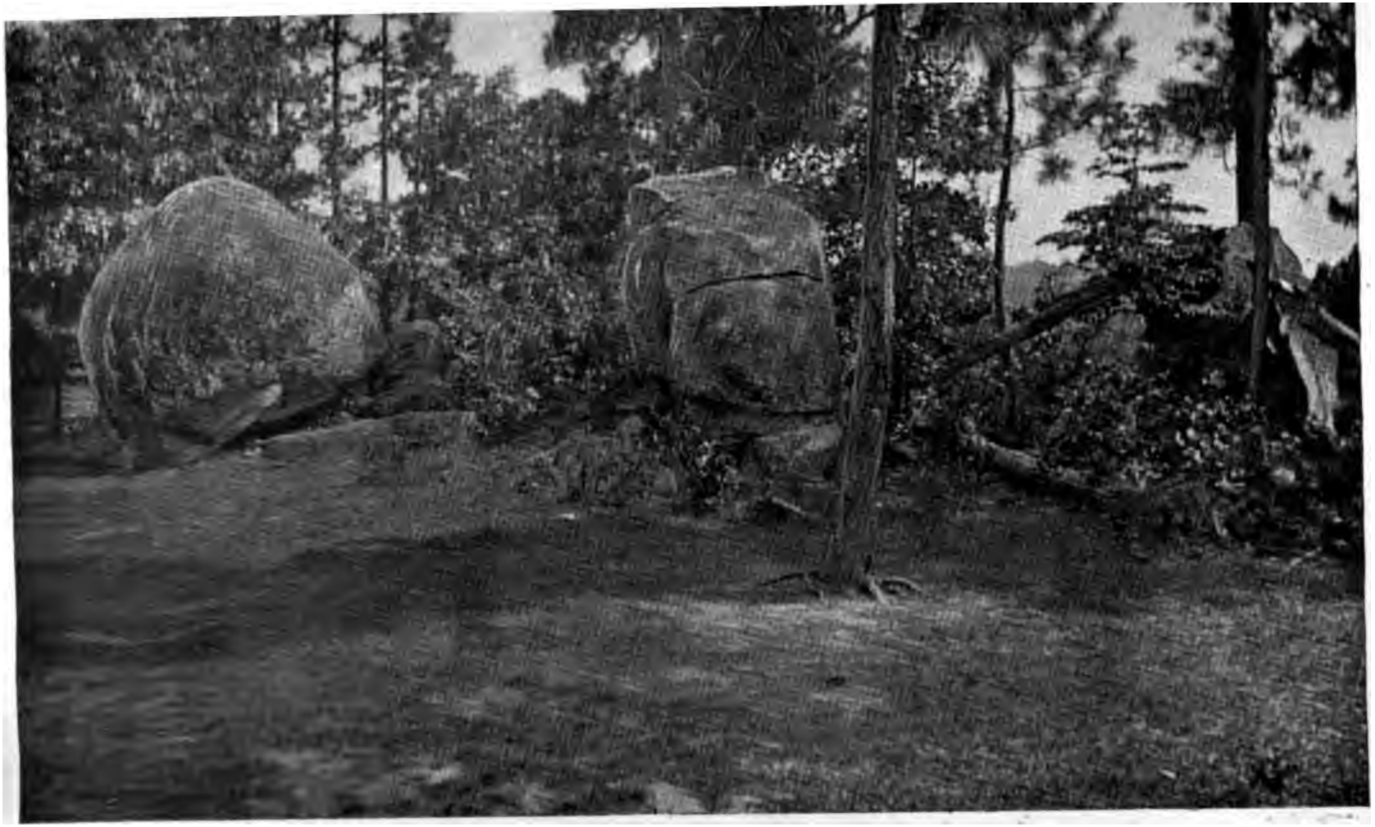
It is seen again at Blake's Ferry on the Tallapoosa. In hand specimens, and even the largest masses exposed, it presents no appearance of stratification; it is, notwithstand-



GRANITE BOULDERS OF DISINTEGRATION. ROCKFORD, COOSA CO.



GRANITE BOULDERS OF DISINTEGRATION ROCKFORD COOSA CO



GRANITE BOULDERS OF DISINTEGRATION. ROCKFORD, COOSA CO.

ing, interstratified with mica slates, has the same strike and dip, and must therefore be called gneissoid granite. The plank road, to a distance below Powelton, passes over the disintegrated edges of the gneissoid rocks, with only here and there a bed of hornblende. The grey soils of this region owe their excellence, for the production of cotton, to the underlying rock. The physical features of the country are also favorable; the surface is undulating, but not broken. On Chenahatchee a very peculiar gneissoid granite occurs, in which the mica is not regularly distributed through the rocks, but occurs in small patches, contrasting curiously with the white feldspar of the rock.

APPENDIX C.

[From Tuomey's Report of 1858, pages 73 to 77.]

STEWART'S GOLD MINE.

This old mine is in Sec. 4, T. 23, R. 17, Coosa County The auriferous portion of the ridge is about 200 feet wide and was at first worked in open cut; but the ridge is perforated by shafts, at intervals, for a distance of one half mile. This mine was worked for some time with stamps, but has long since been abandoned. Masses of bronze colored pyrite are scattered among the refuse; they seem to be portions of a vein cut in the mine, and are more or less auriferous.

The Weoguffka Mountains are composed of talcose slates, which are finely presented at the point where the Weoguffka Creek crosses the Rockford road. About thirty-three miles above Wetumpka the ridges assume a greater elevation, and from their tops the broken character of the country can be seen. The country is covered with a magnificent forest of long leaf pine, which, when seen from above, presents a peculiarly rich and luxuriant appearance. The talcose slates are succeeded by mica slates, which continue till they pass into the gnessoid rocks, near Rockford. On the way to Rockford I examined a curious locality, where immense masses of ferruginous matter occurred on the surface, and excited hopes that they would turn out to be copper gossan; and a shaft was sunk under the supposition that the gossan would be cut at the proper depth below the surface. But, unfortunately, these masses were formed in the same manner as the ferruginous tuxa (tufa?) of Randolph, and did not extend below the surface at all.

Near Rockford, on the land of C. W. Chancellor, there occurs an auriferous deposit of gravel and clay, a portion of which was once worked. Of the gold mines of Coosa Mr. Lieber speaks as follows:

"The old mine near Mr. Griffin's in Coosa occurs in Sec. 4, T. 23, R. 27 E. The works having fallen in nothing is now to be seen. It produced well at one time, and an engine was mounted on the spot, but want of skill, together with mismanagement, prevented success. The auriferous gravel deposits of Alabama present some very peculiar and interesting features. It would be difficult to circumscribe them with regard to their geographical occurrence, since gold is found, in greater or less quantity, in almost all the gravels and sands of the creeks and branches of the metamorphic region, extending even as far South as the Tallapoosa, twenty miles east of Wetumpka, where traces of gold exist. The deposits of the Weoguffka and Hatchet Creeks, in Coosa County, demand, perhaps, the greatest attention. On Messrs. Thomas and Samuel Lambert's place, in Coosa, some of these beds occur, and a fine opportunity is afforded for observing them. The 'packed gravel,' as it is locally termed, immediately underlies the soil and débris of the surrounding rock, and is usually about a foot or eighteen inches in depth. The beds contain a large amount of clay, so that their unctuous touch serves to distinguish them with the hand even under water, from the dry débris which overlies them. The quartz of the gravel is throughout of orange color, of a kind I have not seen in any other auriferous region. It belongs to that compact granular quartz, commonly called 'sugar quartz,' and is probably identical with that which, in Australia, has received improperly the name of 'cairngorm." It is worthy of remark, that I have but in one solitary instance found this peculiar quartz in place, though making its discovery a matter of careful attention. This was at Mr. Richmond Noel's, in Randolph County, Secs. 4, 5, 8 and 9, T. 22, R. 10 E. The bed is here two feet thick, and holds a position between a bed of gneissoid eurite, containing, however, a little white mica, and a body of gneissoid granite, which is the same as that at Hunter's. It crops out in the bed of a branch, whose gravel has been found to be auriferous. The quartz, when newly broken, resembles lumps of good brown sugar. The color is pale lemon within, and orange without. Occasionally pieces are seen which pass from a blood red to a deep claret color, and on the fresh break exhibit correspondingly redder tints than the other.

"To return to the gravel deposits of the Weoguffka: the largest quartz boulder observed contained about four cubic feet. All these, from the smallest to the largest, are much rolled, although the larger ones are not so much rounded and still roughly indicate the original forms of the broken pieces. In these gravel beds we rarely meet with pieces of the slates, gneiss, &c., which are found so abundantly in the dry and not gold bearing beds covering them, and where no powerful action has tended to round the constituent pieces of rock. I am inclined to believe that Zereuner errs in enumerating gneiss as one of the rocks found in the auriferous gravel of Alabama. The specimen had probably fallen in from the upper beds. Occasionally the deposits widen to 150 or even 300 feet, but always depend upon the width of the little valleys. Owing to these depositions the surface of the ground in the valleys is singularly level, and has afforded space for the accumulation of very good soil. Branches are found in some, but not all, of these valleys. The gravel pans from four to twenty particles of saveable gold of a fine color, and there is scarcely a doubt, but that, if suitable locations were selected and proper contrivances chosen for extracting the gold, very profitable operations would be the result, especially when we bear in mind the greasy nature of the gravels, in consequence of which only the very coarsest particles of the metal are saved in panning. The utmost attention should be paid to this fact also in the treatment on a large scale. The Hatchet Creek deposits include what is termed the Miller Gold Mine in Sec. 1, T. 24, R. 20 E., and another close to it in Sec. 11, of the same Township and Range. The former, or old Miller Mine, usually paid about $1.75 per hand, the latter only $1.00. The former was last worked in 1847, by T. Phillips, of Nixburg, with six or eight hands, and averaged, during the summer, from 75c. to $1.00 per hand per diem. The ground worked is extensive, and we find upon it both gravel beds and decomposed talcose and micaceous slates with interspersed masses of itacolumitic quartz. Both were worked, and the operations were all exposed to day, so that now all is in confusion and decay. As many as fifty hands were engaged here, at the same time, in the summer of 1843. The operations were commenced in 1840, but frequent interruptions took place, and indeed these mines were only resorted to when no other employment presented itself. The gold was of a very superior quality and better than that at the old mine, which was formerly worked near the Weoguffka. This spot, if properly managed, might yet be made very productive, and indeed the old gravels might again be worked over to advantage; as a proof of which it may be proper to state that, in the summer of 1854, a man engaged in this operation quite alone, and made over $1.00 a day, by the roughest treatment. Ill health prevented his continuing. Messrs. McElrath Bros., of Cherokee County, now own two-thirds of this mine. The whole valley seems to be auriferous, for a Mr. Ford, an old resident of the neighborhood, now of Texas, sank many pits about, and found only one in which he was unable to obtain gold. It has been already stated that it is impossible to point out all the occurrences of deposit gold in Alabama, and it is almost as difficult to ascertain all the localities at which it might be profitably worked, especially as it may require a long time before a really efficient treatment can replace the present barbarous processes. Future discoveries, too, will probably develop far more than it is possible to show at present."

The country around Weoguffka and Hatchet Creeks is doubtless the most broken portion of the State occupied by the metamorphic rocks, yet in the valleys the soil is good and productive.

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GEOLOGICAL SURVEY

OF

ALABAMA.

UGENE ALLEN SMITH, PH. D., STATE GEOLOGIST.

BULLETIN No. 4.

REPORT ON THE

EOLOGY OF NORTH-EASTERN ALABAMA,

AND ADJACENT PORTIONS OF

GEORGIA AND TENNESSEE.

BY

C. WILLARD HAYES,

Assistant Geologist, U. S. Geological Survey,

1892.

MONTGOMERY, ALA.:
SMITH, ALLRED & CO., STATE PRINTERS AND BINDERS.
1892.

To His Excellency,

THOS. G. JONES,

Governor of Alabama:

DEAR SIR:—I have the honor to submit herewith Bulletin No. 4 of the Geological Survey, a Report on the Geology of Northeastern Alabama and adjacent portions of Georgia and Tennessee, by C. Willard Hayes of the U. S. Geological Survey.

The circumstances which have led to the preparation of this report are briefly these: It has been the avowed policy of the present Director of the United States Geological Survey so to prosecute the work of that Survey in the several states as to make it as useful as possible to the State Surveys. In pursuance of this policy it was agreed some years ago between Mr. G. K. Gilbert in charge of the Appalachian Division of the U. S. Survey, and myself, that a measured section should be made by the United States Survey across the line of outcrop of the geological formations of northeastern Alabama and the adjoining part of Georgia. After full conference the line of this section was so chosen as to embrace the lower end of Lookout Mountain near Gadsden; the section was to be about twenty miles wide, and the thickness of the various geological formations crossed by this survey was to be carefully measured, correlations of these formations with those of other states were to be made, and the geological structure of the region accurately determined. This done, the work of the State survey in the same field could be confined, in great part at least, to the investigation of the natural resources, and a voluminous report is now partly in manuscript descriptive of the deposits of iron ore, clays, limestones, and other useful minerals of this region.

As mentioned by Mr. Hayes, the original plan of this U. S. Survey work has been somewhat modified so that the present bulletin includes a description of a much larger area than was at first intended. This is, however, to the advantage of our survey since we get the report free of all cost for field and office work, which represents by far the greater part of the expense.

Yours very respectfully,

EUGENE A. SMITH.

UNIVERSITY OF ALABAMA, July 1, 1892.

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY,
WASHINGTON, D. C., June 12, 1892.

DR. EUGENE A. SMITH,
State Geologist,

DEAR SIR:—I have the honor to submit herewith the manuscript of a report on the Geology of North-eastern Alabama and adjacent portions of Tennessee and Georgia. Although the greater part was written in 1890, various unavoidable delays have prevented its completion till the present time.

I have indeavored in writing the report to keep it as free as possible from technical terms and without sacrificing scientific accuracy, to present the facts in such a manner as to make them intelligible to the largest possible number of readers in the region under consideration. Many details which would be of interest to the geologist have been purposely omitted and only those which were considered essential are given. It is expected that the atlas sheets covering this region will shortly be published by the U. S. Geological Survey and supply the details to those specially interested, which are omitted from this report.

Very respectfully,

C. WILLARD HAYES,
Asst. Geologist U. S. Geological Survey.

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I. INTRODUCTION.

Field Work.—The information embodied in the following report was obtained during the summers of 1887, 1888, 1889 and 1890, in connection with the mapping of atlas sheets under the Appalachian Division of Geology, U. S. Geological Survey. In 1887, the writer accompanied I. C. Russell through the southwestern portion of the area described, assisting him in the completion of surveys made the previous year. Three months the following summer were spent by the writer in mapping the northeastern half of the area, and some of its eastern portions were revisited in the fall of 1889 in connection with work then being done in southeastern Tennessee. In all about five months previous to the summer of 1890 were spent by the writer in actual field work within the limits of the mapped area. In the summer of 1890 something over two months were spent in the southern and western portions of the field. With the assistance of M. R. Campbell, a somewhat detailed survey was made of the more complicated areas and the conclusions of previous seasons were re-examined and verified.

A very considerable change in the methods of work has taken place since the season of '87. This change was the natural and necessary adaptation of methods to the special conditions under which work had to be carried on in this region. The method first employed was to measure with great accuracy a few lines across the country in a northwest-southeast direction at intervals of about ten miles. It was believed that these would afford ample data for determining the structure and stratigraphy of the region. It soon became evident, however, that work would have to be done along the strike between the measured lines since otherwise most important facts of structure were overlooked. In 1888 the stadia transit with which the earlier lines had been measured was discarded and the geologic data was placed directly upon the topographic map, a few lines being measured with plane table to obtain data for the stratigraphic column. In 1890 the method was still further modified by discarding the plane table and plotting all lines in the note book. The distances are obtained by recording the revolutions of the buckboard wheel or by pacing, and the directions taken from a hand compass are laid down by means of a small horn protractor. The great advantages of this method are rapidity of work, compactness of results, and ease with which previous work is referred to at any time. As much ground can be covered while making such a survey as if only verbal notes were taken; the work of several weeks is contained in a small note book instead of a large number of loose plane table sheets; and finally with the observations constantly before him and in their proper relations the geologist is able to work out in the field details of the problem presented without waiting for the reduction and plotting of data in the office. The admirable points of this graphic method of field work were shown in its application to some of the highly complicated regions as that between Weisner and Indian mountains, or along the fault line north of Coosa river.

Relation to the Work of other Geologists.—From its position along the southern border of Tennessee, much valuable information as to the geology of this region is contained in Safford's classic work, "The Geology of Tennessee." Safford's report, however, is less detailed in regard to the southern part of Tennessee than it is in regard to the central and northern portions of that state, so that only in a broad way can the descriptions be applied to northern Alabama and Georgia. The work of the Alabama geologists on the other hand, has been largely on the southern limit of the Appalachian province along the line where the Paleozoic and crystalline rocks pass under the Mesozoic and later formations. The work done by State surveys in northwest Georgia previous to 1887 was of so fragmentary and superficial a character that it amounted to little more than a reconnaissance.

The region is thus practically a virgin field and occupies a specially important place as the connecting link between the work of Tuomey and Smith in Alabama and Safford in Tennessee. It is also a representative region including as it does all the Paleozoic formations of the southern Appalachians, characteristically developed and types of all the more important forms of Appalachian structure, with some which, so far as our present information goes, are unique.

Scope of the Report.—The scope of the report is general rather than special and detailed. The aim has been to adapt it to the needs of the laymen rather than the professional geologist. It is not intended as an exposition of the mineral resources of the country, but rather as a discussion of the physiography of a limited area with special reference to the origin of the natural features and their relation to the geologic structure. It is hoped, however, that it may furnish information which will serve as a basis for the economic geology of the region, and that it may render intelligible many apparently disconnected and anomalous facts which the observant layman, as well as the prospector and miner, is constantly meeting.

II. LOCATION AND AREA OF THE REGION MAPPED.

The region under consideration extends from longitude 85° to 86° 30′ and from latitude 34° to 35°, forming a rectangular area 85 miles from east to west, and 70 from north to south. The rectangle includes a narrow strip a little less than a mile wide along the southern border of Tennessee. Of the remainder, two-thirds or 3880 square miles, are in Alabama, and one-third or 1940 square miles are in Georgia. In Alabama it embraces Jackson, DeKalb and Cherokee counties and portions of Madison, Marshall, Blount and Etowah; and in Georgia, Dade, Walker, Catoosa, Chattooga and Floyd, with portions of Whitfield, Gordon, Bartow and Polk.

The area is covered by six atlas sheets of the U. S. Geological Survey topographic base map, viz: The Ringgold and Rome sheets lying mostly in Georgia, and the Stevenson, Fort Payne, Scottsboro and Gadsden sheets in Alabama. The accompanying map was compiled from the above named atlas sheets reduced to one-third the original scale, or to very nearly six miles to one inch. The surface elevations are represented by the lines printed in brown called contours. Thus the heavy brown line indicates the position at which a horizontal plane just 1000 feet above sea level would intersect the land surface. This heavy brown line is called the "thousand foot contour." In many places there is a lighter brown line between the heavy one and the streams; this marks the position at which a horizontal plane 750 feet above sea level would intersect the surface, and it is called the "seven hundred and fifty foot countour." The latter plane would be everywhere 250 feet below the one whose intersection with the land surface is marked by the thousand foot contour. Hence the vertical height represented by two adjacent contours is 250 feet; or in other words, the contour interval is 250 feet.

III. TOPOGRAPHY.

Topographic Divisions.

The area covered by the accompanying map falls naturally into three divisions, each characterized by a different type of geological structure and a peculiar topography or surface configuration.

Every feature of a landscape is due to the action and interaction of natural forces. Sometimes the process by which the present form was reached may be traced, and at others it is so complicated as to render this impossible. In regions having a simple geologic history, that is, in which the forces have acted uniformly and always in the same direction, the forms of the surface are seen to be the direct result of processes still in operation. Such a region is the one under consideration. Since its final elevation above the level of the sea in which its rocks were deposited as sediments it has probably never been resubmerged, and while the elevation may have made several halts in its progress it has been fairly continuous. The marks of a fluctuating rise are but slightly if at all manifest.

The chief factors that determine the forms into which the streams will carve a land surface are, first, the angle at which the rocks are inclined to the horizontal, and, second, the difference in hardness between the different beds. Horizontal rocks tend to produce plateaus, and inclined rocks tend to produce ridges. Especially is this tendency manifest where there is an alternation of hard and soft beds, or rather, where there is great diversity in the ability of different beds to resist erosion. The relations between topographic forms on the one hand and geologic structure on the other, will be further discussed in describing the topography of the region.

The three topographic divisions above referred to are: (1) the western, embracing the area northwest of Browns valley; (2) the central, embracing Sand and Lookout mountains with the adjacent valleys; (3) the eastern, embracing the country to the southeast of Lookout mountain.

Topography of the Western Division.

Plateaus or Mesas.—In the western division the rocks are practically horizontal, having only a very slight inclination to the southwest. The topography is that always produced by horizontal beds of varying hardness which have been raised somewhat above sea level so that eroding agents have opportunity to work. It is a typical plateau region. In the plateau regions of the Far West are many elevations with flat tops and steep sides which have been carved from horizontal rocks by stream erosion and left as isolated remnants of an originally continuous plateau. To these elevations the term "mesa" is applied and it may be well to apply the same term to the exactly similar topographic forms of northern Alabama. The mesas all reach nearly the same altitude, about 1,600 feet above sea level. Their broad, level tops show them to be the remnants of a plateau which once extended continuously over the whole of this division and far to the west and north. The remnants of this plateau now occupy only about one sixth of the area within this division of the map, and a still smaller proportion farther west. The rock originally covering the whole region, but now found only as a capping upon the summits of the mesas, is the heavy sandstone forming the base of the coal measures. Below this, which is called the Lookout sandstone, the rocks are largely calcareous for a thousand feet or more. Thus the sandstone rests upon an insecure foundation. As soon as the streams cut through to the calcareous beds, their progress downward is rapid and they readily sink their channels to near the level of the Tennessee river which drains the region. Since the cap rock is more durable than that forming the lower slopes of the ravines, the latter is worn away most rapidly, undermining the capping sandstone. It results from these conditions that the mesas are bounded by cliffs of sandstone below which are steep limestone slopes, usually deeply covered with sandstone debris. When the whole of the protecting sandstone cap has been thus undermined and removed the surface assumes a wholly different character. Low rounded hills or a gently undulating plain replace the mesa with its abrupt slopes and level top.

The heavy mantle of vegetation covering the surface conceals in a large measure the characteristic topographic forms which are so well displayed in arid and treeless regions. Back from the immediate edge of a mesa there is nothing in the gently undulating or level surface to indicate that one is on the top of a mountain.

Topography of the Central Division.

Synclinal Mountains.—The second topographic division, as already stated, embraces Sand and Lookout mountains, forming a broad belt with nearly parallel sides extending northeast and southwest through the central portion of the map. The division is traversed throughout its entire length by Lookout and Wills valleys, separating the two mountains. Near the lower edge of the map the northern extremity of Murphrees valley, known as Bristows cove, interrupts the broad level top of Sand mountain toward its eastern side, while McLamores cove forms a similar deep notch in the northern end of Lookout mountain.

Sand and Lookout mountains are not, strictly speaking, plateaus, though they closely resemble them in many respects. The rocks are not horizontal, but in each case dip gently toward the center, forming broad, shallow troughs. Sand mountain is much the broader and shallower of the two, and hence approaches more nearly to the plateau type. Lookout mountain is narrower and appears, especially toward its southern end, as a deep trough, with high, well defined sides. Both of these mountains resemble the mesas of the western division in their sandstone cliffs with the steep limestone slopes below.

Anticlinal Valleys.—Browns valley properly belongs in the central division and falls in the same category with Murphrees, Wills, Lookout and Chattanooga valleys. All of these are directly dependent on the geological structure and since that is the same in every case are remarkably like in form. The rocks forming the mountains dip away from the *edges* toward the center, while the rocks underlying the valleys dip away from the *center* toward the sides. In other words they are anticlinal valleys. Browns valley passes entirely through the map area, but each of the others named terminates within it in a cove. The anticlinals which determine the position of the valleys, after continuing for long distances, suddenly die out and the rocks instead of forming an arch become horizontal and then merge into the synclinal. At this point the valley terminates in a huge amphitheatre encircled by high sandstone cliffs. The process by which these remarkable valleys were formed will be more fully explained in describing the drainage.

Topography of the Eastern Division.

The third topographic division lies to the southeast of Lookout mountain. Its general surface is but little above the level of the larger streams, though it is interrupted by a number of ridges rising to a considerable elevation, the highest reaching two thousand feet above sea level. There is much greater complexity of geologic structure than in either of the two divisions previously described, and in consequence there is much greater complexity in topographic form.

Monoclinal Mountains.—The ridges are formed by the outcropping edges of hard beds of sandstone which generally dip toward the east or southwest. Some of them extend for long distances with remarkable uniformity in trend and elevation. They are usually unsymmetrical; one side, the face of the ridge, being steep and rugged, while the other, the back, has a smooth and gently ascending surface. This difference is caused by the position of the sandstone beds as shown, for example, in figure 1, which is an east and west section through Armuchee valley. The elevation represented in profile at T is Taylors ridge and its western side is formed by the broken edges of the sandstone, while the eastern slope coincides very nearly with the dip of the beds.

The difference in slope between the face and back of the ridge becomes less with an increase in the dip, and where the rocks approach the vertical the ridge is symmetrical. This form is shown in the same section Figure 1, by the elevation D which represents Dicks ridge.

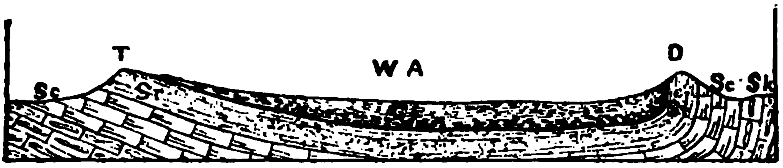


Figure 1. Section from Dicks ridge D, through West Armuchee valley W A, and Taylors ridge T; showing *unsymmetrical* and *symmetrical* ridges depending on the *dip* of the *strata*.

The ridges northwest of the Coosa valley are produced by the sandstone of the Rockwood formation, and form a group with similar characteristics, while the most of those south of the Coosa valley are formed by Cambrian sandstone. The latter are less uniform and continuous in character. The principal ridges, Weisner and Indian mountains, are comparatively short, tapering off rapidly in either direction from a culminating point near their central portions.

Flatwoods.—A marked topographic feature of this division is the Coosa valley. The Coosa river from Rome southwest to the edge of the map at Gadsden swings back and forth across the broad level valley that has been cut in the soft calcareous shales and limestones of the Cambrian. The actual flood plain is not extensive and the highly contorted shales are generally exposed along the banks of the river. The country back from the alluvial flood plain is poorly drained and heavily timbered, and to this the term "flatwoods" is applied. While most of the flatwoods districts are underlain by Cambrian shales they are not confined to that formation. A considerable area north and west of Rome in the Oostanaula valley is underlain by Carboniferous shales but retains all the characteristics of typical flatwoods.

Chert Hills.—It remains to speak of one other type of surface largely represented in the southwestern part of this division and also to the west of Taylors ridge. In the lower portion of the Silurian is a great thickness of magnesian limestone or dolomite containing large quantities of silica in the form of chert or flint. The outcrops of this formation, the Knox dolomite, are marked by heavy deposits of residual materials left by the solution of the carbonates. These residual materials, consisting of red clay and chert, cover broad areas forming a series of low rounded hills without apparent regularity. The underlying rock seldom appears at the surface. There are few small streams since the water which falls upon such an area is absorbed by the layer of porous residual material and reappears in springs at the edge of the outcrop.

IV. DRAINAGE.

Streams of the Western Division.

The region under consideration is about equally divided between the drainage basins of the Tennessee and Coosa rivers with a small area in the southwestern corner in the Black Warrior basin. The larger part of the western topographic division lies in the great bend of the Tennessee river. The arrangement of its streams is for the most part approximately radial. They flow from the high land along the Alabama-Tennessee line southeast, south, and southwest to the nearest point of junction with the river.

Formation of Limestone Valleys.—The fact that the valleys of this section are underlaid by limestone has already been mentioned as well as the method by which they were formed, in describing the intervening sandstone-capped mesas. The readiness with which this limestone is dissolved gives the streams a very different character from those flowing over sandstone or other rocks which must be worn into small fragments and carried away by the stream. When that is the case the stream can not lower its bed faster than it can carry the material away, and in order to carry any considerable amount it must have sufficient fall to give its water the necessary velocity. If the rock over which the stream flows is such that it can easily be ground up into mud or fine sand, then a moderately swift current will carry it along; but if it forms coarse gravel or bowlders a steep descent and swift current are required to do the transporting. Hence a stream flowing over rocks which have to be carried away as mud, sand or gravel cannot erode its bed below a certain level, depending on the size of the fragments which it is compelled to carry. With a stream flowing over rocks which may be dissolved, however, it is very different. A swift current is not necessary to carry off the material which is held in solution, but the most sluggish current is just as efficient as a more rapid one. Hence the lowering of the bed of the stream is not limited but continues until the valley is nearly as low as the mouth of the stream. Beyond this, of course, it can not go, since it must have some descent. A stream which is no longer deepening its channel is said to be at *base level.* This is the condition of the streams of this western division. Excellent examples are Flint river and Paint Rock river. Both have reduced their channels almost or quite to the base level of the Tennessee river and their currents are very sluggish, not rapid enough to remove sand and gravel though sufficient to remove the limestone by solution. The head branches of these rivers, rising upon the sandstone capped mesas have a very rapid fall, since most of the descent from these high levels to the level of the Tennessee valley is confined to a few miles at their source.

Streams of the Central and Eastern Divisions.

Consequent Streams.—The radial arrangement of the streams which characterizes the region in the great bend of the Tennessee river, like the plateau topography, is possible only in regions having horizontal or but slightly inclined strata, for where the strata are highly inclined they influence the course of the streams and compel them to flow in certain definite directions. This is seen in the drainage of the central and eastern divisions which is wholly different from that of the western. The streams are *consequent,* that is, their courses are dependent on the geologic structure being determined by the dip of the strata and the relation of hard and soft beds. A consideration of the manner in which the streams have carved the surface of the land into the present form will make clear this relation between the dip of the strata and the present position of the stream channels. It is true that this process has been an extremely slow one, and the change produced in a single generation is almost imperceptible. But careful study shows that every year the agents at work accomplish a little, and if sufficient time is given they are fully competent to produce the greatest results.

Examining the map it will be seen that the streams of the central division do not meander over the surface in an indefinite way with broad curves such as are seen, for example, in Paint Rock river. If a straight line be drawn from the head of Wills creek to the point where it leaves the valley west of Attalla, it will be seen that the stream does not deviate a mile from this line on either side in flowing a distance of nearly fifty miles. For a shorter distance the course of Little Wills creek is even nearer to a straight line and almost exactly parallel with that of the larger stream. Black creek, Little river, Chattooga river and West Chickamauga creek all show similar rectilinear and parallel courses. Now why does Wills creek pursue such a remarkably direct course for this great distance, and why are the courses of Little Wills and Black creeks almost exactly parallel with it? These questions can be answered by considering the history of these streams from their beginning to the present time.

Formation of Anticlinal Valleys.—It must be remembered that the rocks of the region, which will be described later, were all laid down in horizontal beds upon the sea bottom. Sometimes the sea was deep aud limestones were formed; at other times it was shallow and the shore was near by, when mud and fine sands were spread out by the currents to form shales; and finally the surface on which deposits were being made stood for a long time very near the sea level, sometimes a little below it, receiving layers of mud and sand, and sometimes far enough above it to support a luxuriant vegetation whose remains are found in seams of coal. But during all this time there were no stream channels. Or if any were formed while the surface was above sea level they were obliterated by the first layer of sand deposited when the surface was again submerged. Finally the surface emerged from the sea for the last time, and then the ancestors of the present streams were born. The first drainage was determined by the inequalities of the rising surface, and these where doubtless in the form of gentle undulations parallel with each other and extending in a northeast and southwest direction, the beginnings of the present anticlinal and synclinal folds. Thus a long low ridge with gently sloping sides and rounded top occupied the present position of Wills valley. Toward the north it died out between the points of two similar ridges which occupied the positions ef Deer-head and McLamores coves West of Sand mountain was a still longer ridge of the same character where Browns valley now is and east of Lookout mountain was a somewhat shorter but broader ridge in the place of Broomtown valley. Between these ridges which occupied the position of the present valleys were broad shallow depressions, the present mountain summits; that is, the original relation of high and low land has been exactly reversed. How did this come about?

Water falling upon this surface would naturally flow down from the sides of the ridges into the broad shallow depressions between, and collecting into larger streams would flow off in the direction in which the trough happened to slope. The slope of the troughs in this particular region was toward the southwest so that there must have been a stream rising upon the slopes of the ridge which then occupied the position of McLamores cove and flowing southwest through the whole length of the Lookout mountain trough. Another stream rose north of the edge of the map and flowed southwest in the Sand mountain trough. This was the first stage in the development of the drainage system and the probable condition of things may be represented by figure 1, plate I, in which the position of the stream originating in the Lookout mountain synclinal trough is indicated as B–B, and that in the Sand mountain trough as T–T. Into these two main streams the small side streams, l, l, l, and s, s, s, flowed in opposite directions from the top of the intervening anticlinal ridge.

At first these streams were all flowing upon the same kind of rock, probably coarse sandstone, so that they were able to erode their channels most rapidly where the fall and consequently the transporting power of the stream was the greatest. But the slope of the synclinal troughs was very slight so that the main streams had little power to deepen their channels while the side streams flowing into them from the intervening ridge, although they were much smaller, still by reason of their greater fall eroded their beds more rapidly.

If the rocks of this region had been uniform in character for a long distance down from the surface, the effect of the more rapid cutting of the side streams would have been simply to reduce the height of the intervening ridge, leaving the main streams in their original position in the synclinal troughs. But the rocks are not homogeneous. They consist of alternating hard and soft beds and after the side streams had cut down a few hundred feet they came to layers of shale and then limestone which they could remove much more rapidly than the overlying sandstone. As soon as a side stream reached these soft rocks at any point it tended to widen its valley at that point by removing the soft rocks so as to undermine and thus break down the overlying harder beds. By a continuation of this process lateral valleys were formed, figure 2, plate I, extending in the direction of the ridge and at right angles to the side streams.

This may be regarded as the second stage in the development of the drainage system, and be represented by figure 2, plate I.

The two streams *w* and *w'* cut away at the divide *d* and the stream *w* having the lowest outlet was able to erode more rapidly than *w'* and so pushed the divide nearer and nearer toward the side stream *l'* till finally it tapped the latter and led its waters off by way of *l*. The lateral stream thus formed (*w w*, figure 3, plate I.), was the beginning of the present Little Wills creek. The same process would have continued till this stream had tapped successively all the drainage basins above if it had not encountered a second hard bed through which erosion was very slow. After the soft rocks were removed which lay above this hard bed, then the same process was repeated which had taken place on the original anticlinal ridge; that is, side streams with greater fall were able to cut through the hard bed more quickly than the main stream and reaching soft rocks below began to widen their valleys and then form lateral valleys at those points. The same process was repeated with this second set of lateral streams. By erosion at the divides, D, D′, D″, etc., figure 3, plate I, that one having the lowest outlet tapped the drainage basin of the one adjacent and led its waters off along the axis of the anticlinal. The side stream W, (figure 3, plate I.) possessed a great advantage over any of the others in having a much lower outlet and hence it was able to encroach upon them and divert their headwaters to its own channel. But with each conquest of new territory, by the additional volume of water thus gained, it became more efficient in eroding its valley while the streams whose drainage basins had been thus diminished were even less able to hold their own. Thus the process was cumulative in its effects and finally the stream last formed became the dominant one of the drainage system.

This process by which the ridge was removed and the streams shifted from their original position in the synclinal trough to the axis of the anticlinal may be further illustrated by the diagram, figure 2, representing a section through the ridge and adjacent troughs. The heavy line represents the present surface and the unbroken lines the beds of rock as they exist at present, below the surface. The curved, dotted lines represents the position of the beds as they originally existed before their removal. Two of these beds, Cl and Sr, which are sandstone, offer much greater resistance to erosion than the limestones Cb, Sc and Sk. The upper curved line

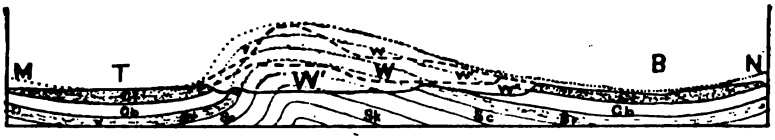


Figure 2. Section through Lookout mountain, Wills valley and Sand mountain; showing profile of the land surface at four stages in the development of the present drainage system.

represents the profile of the land surface on which drainage originated, corresponding in position to the line M N in figure 1, plate I. B and T indicate the position of the main streams in the synclinal troughs into which the side streams flowed from the intervening anticlinal ridge As already explained the first point at which the upper hard bed Cl was cut through was on the steep slopes of this ridge as at w and v, where the lateral valleys were subsequently formed in a direction parallel with the ridge. The upper broken line, then, will represent the surface at the second stage of its development represented in figure 2, plate I. Continuing to erode their channels downward through the soft rocks Cb, the streams encountered the second hard bed Sr, and the process above described was repeated, producing the surface represented by the lower broken line. This is the third stage in the development of the drainage system in which the streams had the positions indicated in fiure 3, plate I. Finally the lateral stream which started at W, being already through the two hard beds, easily distanced its competitors and robbed them of successive portions of their drainage area until it became the dominant stream of the system, Big Wills creek.

The stream, BB, figure 1, plate I, which originally flowed the whole length of the Lookout synclinal trough, was not permitted to retain that position. Robbed of all its western tributaries by the process above described, it was unable with its diminished volume to lower its channel sufficiently fast for its own protection. At a point on the eastern side of the synclinal a stream, RR, figure 3, plate I, has cut back from the valley of the Coosa and diverted the upper portion from its original channel. Hence the present course of Little river, figure 4, plate I., follows the synclinal to this point and then turns sharply to the southeast by a deep rocky gorge. Other portions have been more recently diverted by Wolf and Yellow creeks. Thus the stream which originally drained the whole of the synclinal trough and the slopes of the adjacent anticlinal ridges has been robbed of the greater part of its drainage basin and Black creek alone, a mere remnant of the original stream, retains the course which it has followed from the beginning. For a short time, during the stage represented by figure 3, plate I., Little Wills creek, w w, was the encroaching stream, but reaching a hard stratum its career of conquest was checked and the stream W, more favorably situated, although last born, became the dominant stream of the system. In the meantime the anticlinal ridge had been entirely removed and in its place a deep valley excavated, while the original stream channels were left high up in the synclinals now forming the tops of the mountains.

This is but one of numerous examples in this region which might be followed out in detail to show how the drainage system has adjusted itself to the structural surface and how the present position of the streams is dependent on the dip of the strata and the alternation of hard and soft rocks.

It must be borne in mind, however, that only the latest stages in the development of the present topography can be followed with certainty. The condition which immediately preceded the present is easily inferred but as the processes are followed backward they become more obscure and finally are only to be conjectured. Hence in the development of Wills valley as it has been sketched above, the explanation becomes more largely pure hypothesis as the more remote stages are reached. The explanation offered for the earliest stages is not the only one possible, but is perhaps the most probable of a number which might be given.

Also in the above sketch several complicating factors have been purposely omitted for the sake of greater simplicity in presenting the essential points of the theory. Thus the anticlinal arch probably continued to rise during the process of erosion and the effect which this may have had on the resulting topography has not been taken into consideration.

Again, the faults which occur at frequent intervals along the western side of Wills valley must have exerted an important influence, since along the fault line the rocks are fractured and crushed so that they afford less resistence to erosion than elsewhere.

The date of the inception of these faults would also have a bearing on the problem, and their influence on the course of development of the valley would be one thing if they were formed near the beginning of the folding and quite another if formed after erosion had made some progress.

This uncertainty as to details, however, does not affect the general theory of the formation of anticlinal valleys. The most important feature of the theory is the encroachment of one stream upon the drainage basins of those adjacent, and this rests upon evidence wholly free from the doubt above indicated.

V. STRATIGRAPHY.

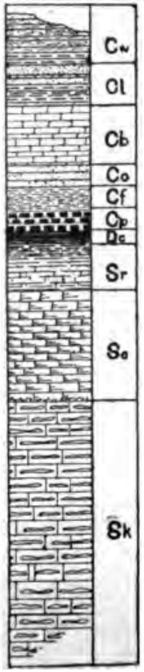
General Classification of the Rocks.

The rocks of the area under consideration belong wholly to the Paleozoic system and include representatives of all its larger subdivisions or periods. None of them have undergone metamorphism to any considerable extent. The western limit of the metamorphic rocks lies a short distance to the east of the area. There is much doubt as to the horizon to which these metamorphic rocks belong and this can only be determined, if at all, by much further detailed study; but with regard to all the rocks within the map area there is no serious difficulty in determining at least approximately their proper stratigraphic position.

The formation names employed are such as avoid all remote correlations, being purely geographic and taken from localities within the area described or in contiguous areas from which they have been continuously traced. The basis of division is a lithologic one, a *formation* being a group of strata which clearly belong together by reason of their general similarity in composition, implying a uniformity in the conditions of sedimentation during their deposition.

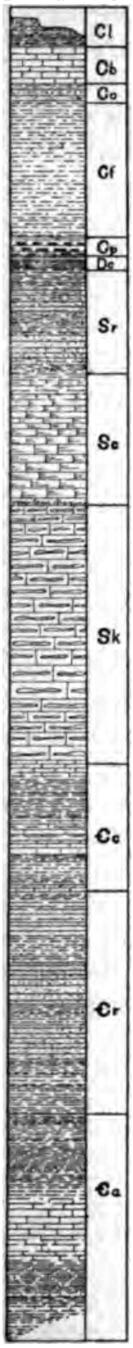
The accompanying table shows the subdivisions made within the area and also the names which have hitherto been applied to the same rocks by Smith and Safford. Wherever changes have been made from the usage of these geologists it has been in accordance with the general principles of nomenclature above stated:

PERIOD NAMES.		Formation names and symbols used in this Report.		NAMES HITHERTO APPLIED TO THE SAME ROCKS.		
				Smith: Geology of the valley region adjacent to the Cahaba coal-field, 1890.	Smith: Outline of the Geology of Alabama, 1878.	Safford: Geology of Tennessee, 1869.
Carboniferous.	Coal measures.	Cw.	Walden sandstone.	Coal measures.	Upper coal measures. Lower coal measures.	Coal measures.
		Cl.	Lookout sandstone.		Millstone grit: Conglomerate	
	Mississippian.	Cb.	Bangor limestone.	Bangor limestone.	Upper sub-carboniferous, or mountain limestone.	Mountain limestone.
		Co.	Oxmoor sandtone.	Oxmoor sandstone and shales.		
		Cf.	Floyd shales.			
		Cp	Fort Payne chert	Fort Payne chert.	Lower sub-carboniferous	Siliceous group.
Devonian.		Dc.	Chattanooga black shale.	Black shale.	Genesee or Black shale.	Black shale.
Silurian.		Sr.	Rockwood formation	Red mountain or Clinton.	Clinton or Dyestone.	Dyestone group: Whiteoak mountain sandstone, Clinch mountain sandstone.
		Sm.	Rockmart slate.		Cincinnati or Nashville.	Nashville.
		Sc.	Chickamauga limestone	Trenton or Pelham limest.	Trenton, chazy or maclurea.	Trenton or Lebanon maclurea limestone.
		Sk.	Knox dolomite	Knox dolomite.	Quebec or Knox dolomite	Knox dolomite.
Cambrian.		Cc.	Connasauga shale.	Choccolocco or Montevallo shales	Knox shales.	Knox shale.
		Cr.	Rome sandstone.			
		Cw.	Weisner quartzite.	Weisner quartzite.	Calciferous or Knox s. s.	Knox sandstone.
		Ca	Coosa shale	Coosa shales.	Potsdam or Chilhowee.	Chilhowee sandstone.



PERIOD NAME.	STRATIGRAPHIC COLUMN.	THICKNESS.	FORMATION NAME.	TOPOGRAPHIC FEATURES.
CARBONIFEROUS.	Cw	500+	Walden sandstone.	Level or rolling plateau summits.
	Cl	60-600	Lookout sandstone.	Cliffs and steep slopes.
	Cb	320-800	Bangor limestone	Mountain slopes and valleys.
	Co	0-380	Oxmoor sandstone. . . .	Terraces on mountain slopes or low ridges.
	Cf	0-340	Floyd shale.	Narrow valleys.
	Cp	140-300	Fort Payne chert.	Narrow sharp ridges parallel with the mountain escarpments.
Devonian	Dc	20-60	Chattanooga black shale	
SILURIAN.	Sr	170—-650	Rockwood format'n	
	Se	800—-1400	Chickamauga limestone.	Level valleys.
	Sk	2000—2500+	Knox dolomite. . . .	Irregular rounded hills.

Figure 3. Columnar section showing the character and relative thickness of the strata exposed west of Broomtown valley.



OD E.	Thickness.	Formation name.	Topographic features.
	200–300	Lookout sandstone	Cliffs and steep slopes.
	300–500	Bangor limestone.	Steep mount'in slopes and valleys
	0–250	Oxmoor sandstone	Low ridges.
	1200—1600	Floyd shale........	Broad level valleys.
ian	50–210	Fort Payne chert	
	0–50	Chatta. black shale.	
	870—1600	Rockwood format'n	High steep ridges.
	1100—1800	[Rockmart slate.] Chickamauga limestone.	Valleys and low'r slopes of ridges
	3000—3500	Knox dolomite	Low irregular hills and ridges.
	1600—2000	Connasauga shale..	Narrow valleys.
	2000—3500	Rome sandstone.. Weisner quartzite?	Comby ridges. High irregular ridges.
	3000+	Coosa shale	Broad level valleys "Flatwoods."

1. Columnar section showing the character and relative thickness of the
posed east of Broomtown valley.

In the following pages the several formations will be taken up in order, beginning with the oldest, and described with reference to their (1) lithologic character, (2) areal distribution, and (3) topographic features.

Cambrian Rocks.

The oldest rocks in the area under consideration belong to the Cambrian period. They are divided into three formations, as follows:

3. Connasauga shale; calcareous gray shale with beds of oölitic limestone at the bottom, and blue seamy limestone toward the top.
2. Rome sandstone; variegated sandy shale and thin bedded red and brown sandstone, including the Weisner quartzite in lenticular beds.
1. Coosa shale; calcareous shales with beds of limestone; also calcareous and siliceous nodular concretions.

The above subdivision of the Cambrian rocks is based wholly upon their lithologic character, and all correlation with other regions is purposely avoided. It must be regarded however, as only tentative, since a thorough study of the fossils contained in these rocks will doubtless necessitate considerable changes. Mr. C. D. Walcott has reached the conclusion from very recent study of fossils collected by Dr. Cooper Curtice, that most, if not all the rocks embraced in the above named formations, belong to the Middle Cambrian. Mr. Walcott is also inclined to regard some of the rocks along the northwestern side of Coosa valley which are included with the Coosa on the accompanying map, as equivalent to the Connasauga shale. But further study, both of the fossils and the structure of Coosa valley, will be required to decide this point.*

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* The stratigraphic succession from the Connasauga shale downward through the Rome sandstone into the Coosa shale has always been considered without break or unconformity. The very different physical appearance of the two shale formations with their interbedded limestones made this the natural interpretation and one would hesitate to pronounce them equivalent except on the clearest evidence. Since the accompanying

Coosa Shale.—**C**c. To the lowest division of the Cambrian rocks the name Coosa shale has been applied from the locality where it is best developed, the Coosa valley between Rome and Gadsden.

The typical Coosa is a finely laminated shale, greenish, yellowish or gray in color, weathering to a heavy gray soil. The shale generally contains beds of limestone, though it may be locally free from any large amount of calcareous matter. These beds of limestone form the most striking characteristic of the formation. In thickness they vary from several feet forming nearly the whole mass, to less than an inch with thick bands of shale intervening. Frequently in place of continuous beds the shale is filled with flat limestone concretions about half an inch in thickness and a few inches broad with irregular rounded outlines. These concretions are arranged in regular layers separated by from one to three inches of shale, and projecting from the shale surface along the banks of streams, present a characteristic appearance which readily distinguishes the formation. In

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map was prepared and this report sent to press, however, additional field work has been done which throws light on the question and adds the weight of structural evidence to the conclusion suggested by Mr. Walcott after a study of the fossils that the Connasauga and Coosa shales occupy the same stratigraphic position. A careful study of the region north and south of Rome, Ga., revealed the presence of an extensive fault immediately west of the belt of Rome sandstone by which the shales above the sandstone are repeated so as to appear conformable to and below it. Some small areas of Knox dolomite were found along the fault line dipping under the Rome sandstone; and for the first time beds of oolitic limestone, always considered characteristic of the Connasauga, were found in the shales heretofore called Coosa. It is probable that other faults parallel with the first, but whose existence has not been so clearly proven, cause the Connasauga shale to be several times repeated in such a manner as to extend entirely across the Coosa valley. The striking differences in physical appearance of the Connasauga and Coosa shales are probably to be accounted for by secondary changes in the latter, brought about by the folding and faulting to which they have been subjected in a much higher degree than the former. The differences may be due in part to different conditions of deposition such as nearness or remoteness of shoreline. Unfortunately the cessation of field work will delay for the present the working out of details of structure and stratigraphy in this extremely interesting region.

other parts of the formation similar shaped concretions are abundant, but composed of silica instead of lime. These siliceous concretions accumulate on the surface and very closely resemble deposits of water worn gravel.

The shales are almost always highly contorted, and the limestone beds are filled with a reticule of white calcite veins, while the limestone itself is usually dark blue in color. No reliable estimate can be formed as to the thickness of the Coosa, but from the broad area covered, even allowing for the contortion which it has undergone, it must be at least several thousand feet.

The Coosa shales, and indeed all the Cambrian rocks, are confined to the division east of Lookout mountain, although a little further south they have a much greater westward extension in Jones and Murphrees valleys.

The largest area occupied by the Coosa shale is the Coosa valley between Rome and Gadsden. The length of this belt within the map area is about forty miles, and for twenty-five it has a breadth of ten miles. Approaching the eastern end, it tapers off into a numbr of long slender fingers, being separated by a fault from the younger rocks on the north This fault will be described later. After a slight break at Rome, the same belt continues northeastward to the edge of the map, forming the valley of the Oostanaula river. The western edge which is limited by a fault as further south, is very irregular and several projecting arms extend toward the west where they lie upon rocks which belong much higher in the series.

Areas of Coosa shale are generally characterized by the type of surface known as "flatwoods." A large proportion of the rock material is removed by solution and the soft shales remaining offer but little resistance to eroding agents. The residual soil is a cold, stiff clay, poorly adapted to cultivation and hence is largely permitted to retain its native forest growth.

Rome sandstone and Weisner quartzite.—**Cr.** Above the Coosa shales is a group of sandy shales, sandstones, and quartzites of undetermined but variable thickness. The name of the formation is taken from its typical development at Rome, though it shows wide variations from this type both in thickness and lithologic character.

The base of the formation consists of several hundred feet of highly indurated greenish sandy shale. This is always contorted with much crushing and the breaks are partially filled with veins of quartz which are seldom more than half an inch thick. Above this layer of greenish sandstone is a great thickness of sandstones generally thin bedded and frequently passing into sandy shales. They are usually purple or reddish brown in color and show abundant suncracks and ripple marks. The upper part of the formation consists of shales frequently highly colored in alternating bands of red, purple, yellow, chocolate and green. It is impracticable to separate these shales from the sandstone on account of their intimate intergradation. By a very gradual decrease in the proportion of sand the formation changes from sandstone to shale with no abrupt break in the transition. It also changes along the strike so that while some sections show the sandstone extending nearly to the top of the formation, others not far distant show it composed almost entirely of shale.

Among the purple sandstones are occasionally intercalated beds of white sandstone or quartzite, from a few feet in thickness to many hundred. It is called the Weisner quartzite, from its typical development in Weisner mountain. This quartzite has hitherto been correlated with the Potsdam of New York and the Chilhowee of Tennessee, but although it resembles both of these formations in lithologic character, there appears to be no sufficient ground for assuming that they are contemporaneous deposits. Especially is the name Chilhowee objectionable, since the rocks which have been classed together under that name appear from the work of Willis and Keith in Tennessee to belong to several widely separated horizons. The Weisner quartzite probably does not occupy an invariable position in the Cambrian series, but may occur at any point, within certain limits, having been produced by the rapid local accumulation of pure sand contemporaneously with the slower deposition of sandy mud which formed the Rome sandstones. Hence the Rome sandstone and the Weisner quartzite are not regarded as distinct formations, but as different lithologic types of the same, due to local differences in the condition of sedimentation.

In the Cambrian areas of Chattooga valley the Rome formation is either wholly wanting or represented by fine shales which have not been separated from the overlying Connasauga. If the formation contains sandstones in this region they have not yet been uncovered by erosion. To the east of Taylors ridge the formation is represented by a belt of purple and brown sandy shales with only occasional beds of true sandstone. Apparently growing more sandy toward the southeast, the Rome reaches its greatest development along the eastern border of the Oostanaula-Coosa valley.

The distribution of the Weisner quartzite is quite circumscribed. It occurs strongly developed in only two localities, at Weisner mountain and a few miles to the eastward at Indian mountain, both on the southern edge of the map. There is a profound fault between the two and it is possible that they originally formed a continuous bed, but on this point there is at present but little evidence available. It is quite probable that they are wholly distinct local developments of quartzite at different horizons in the formation They form the northern members of a series of similar lenticular quartzite masses which extend to the southwest nearly to the southern limit of the Paleozoic rocks.

The Rome formation produces a series of comby ridges varying in height with the proportion of sandstone and shale and its degree of induration, but always sufficient to form a strong contrast with the flatwoods country of the adjacent Coosa shales. The many knobs and short ridges north and south of Rome are good types of the topography resulting from the weathering of these rocks.

The Weisner quartzite is the most obdurate rock of the region, and wherever developed in any force, forms bold ridges steep and rugged on the side formed by outcropping edges of quartzite and sloping more gradually with the dip of the beds on the other side.

Connasauga Shale.—**C**c. Above the Rome sandstone is another series of shales and limestones forming the upper division of the Cambrian rocks as they occur in this region. The formation is named from its typical development in the Connasauga valley of northern Georgia. It corresponds in general with the Knox shale as described by Safford. The formation consists of gray calcareous shales alternating with beds of limestone. The limestone is most abundant toward the top where it frequently occurs almost entirely replacing the shale for several hundred feet in thickness. It is separated into thin beds by seams of argillaceous material which are scarcely visible on fresh surfaces, but become prominent by weathering, since the lime is dissolved away leaving behind the insoluble clay forming the seams. There is no sharp line separating the shales from the beds of limestone, but one passes into the other by insensible gradations. Wherever the clay seams increase slightly in thickness and number the rock weathers to a bed of shale, and when they decrease it appears as a bed of limestone.

The lowest beds of limestone which mark the base of the formation have a peculiar oölitic structure. The rock is largely made up of small round grains the size of bird shot. Sometimes these grains or oölites are flattened or elongated. They are wholly different in their orign from the rounded quartz grains of which sandstones are composed. The latter have been rounded by the action of water in streams or waves rubbing them against each other and so wearing off their corners, but the grains of the oölitic limestone were formed in their present position in the rock itself though the process by which they were formed is not thoroughly understood.

The Connasauga forms a long narrow belt in Chattooga valley, extending toward the north beyond the limits of the map. At the southern end of this strip this upper division of the Cambrian is brought in contact with the Coosa by a fault. Where the two shale formations come together it is difficult to draw a line between them and some of the shales on the western side of Coosa valley may be found to be Connasauga instead of Coosa as they are represented on the map. The Connasauga forms a long narrow strip bordering the Rome which lies east of Taylor's ridge and a still more extensive strip parallel with the Rome sandstone which has already been described as bordering the Oostanaula-Coosa valley. At no point west of Lookout mountain has erosion cut deep enough to expose these rocks, though probably they do not lie far below the surface in Wills valley.

The Connasauga shales invariably give rise to valleys lying between the more obdurate Rome sandstone on the one hand, and rounded hills of residual clay and chert on the other. When the limestone makes up a considerable proportion of the formation, these valleys have a deep red soil, as in the case of Van's valley, north of Cave Spring, Georgia. When the argillaceous shales predominate the soil is apt to be rather sterile.

Silurian Rocks.

The rocks of the Silurian period are divided into three formations, as follows:

3. Rockwood formation. On the northwest calcareous shales, becoming sandy shales and coarse sandstones toward the southeast.
2. Chickamauga limestone. On the northwest blue limestone, becoming argillaceous in the upper part toward the southeast.

1. Knox dolomite. Massive, cherty, magnesian li stone, becoming sandy toward the southeast.

Knox dolomite.—Sk. The lowest of these formations the Knox dolomite of Safford. It is usually a rather coarsel crystalline, sugary, magnesian limestone, though it is sometimes compact and fine grained resembling lithographi stone. The color is generally light gray, but varies all the way from white to dark blue. The chief characteristic of the formation is the large amount of silica which it carries, mostly in the form of chert, though sometimes disseminated throughout the mass as glassy siliceous grains, in which case the product of weathering is a coarse porous sandstone. The chert occurs in layers of flattened nodules which are frequently banded parallel to the outer surface. The nodules pass into continuous beds and in some cases these beds of chert make up the larger portion of the rock with but little calcareous matter intervening. The formation is between 3,000 and 3,500 feet in thickness, thinning slightly toward the south.

The Knox dolomite occupies long narrow strips in the central and eastern portions of the map area. It comes to the surface along the anticlinal axes, or as a narrow strip on either side when the Cambrian rocks are exposed along the center of the anticlinal. The largest area of dolomite is in the southeastern portion where these rocks form a broad gently undulating synclinal.

The weathering of the Knox dolomite gives rise to a characteristic topography. The carbonates of lime and magnesia are removed by solution, and there is left behind a large amount of insoluble clay and chert. The surface, deeply covered with this residual material, bears few running streams. Large numbers of sink holes receive the water alling on the surface, and from these it finds its way through averns dissolved in the rock itself, emerging at length in rings along the borders of the adjacent formations. The rface is covered with a series of low rounded hills without y apparent regularity of arrangement, except that corresponding with the outcrops of the dolomite. When the chert forms the greater part of the rock mass, greater regularity in arrangement results, and high steep ridges are formed in place of rounded hills. This is apt to be the case also, where the dolomite has a very steep dip.

Chickamauga Limestone.—Sc. The second division of the Silurian, lying next above the Knox dolomite, is the Chickamauga limestone. The name is taken from the Chickamauga valley, where the formation has its greatest development within the map area, and is intermediate in character between its western and eastern phases. The formation includes the rocks classed as Nashville or Cincinnati, Trenton and Chazy by Smith, and as Nashville and Trenton or Lebanon by Safford. Whatever correlations or subdivisions may be made, based on the evidence of fossils, the formation from top to bottom is essentially a lithologic unit. It is, in its western exposures, a blue, flaggy, highly fossiliferous limestone, with some local variations of minor importance. From the eastern edge of Lookout mountain, there is a gradual and uniform change toward the southeast. The change consists in a decrease in the abundance of fossils and calcareous material, and an increase in argillaceous matter; the limestone becomes more earthy and along the eastern edge of the map area is red or dove colored and sparingly fossiliferous. In its unweathered condition it is still essentially a limestone, but by the leaching out of the calcareous matter it usually appears at the surface as an earthy non fissile shale.

In the southeastern corner of the sheet the Chickamauga is differentiated into two well marked formations. The lower portion retains much the same character that it has toward the west being a rather massive blue limestone with some beds which weather to shale. The upper portion, however, is composed of calcareous shale which by the development of a very perfect cleavage forms the Rockmart roofing slate.

In the southern part of the area the base of the Chickamauga is locally marked by a heavy bed of breccia, composed of angular or slightly rounded fragments of chert. In some places the bed is made up almost wholly of these chert fragments, with but little cement, and it shows all gradations from this extreme to a fine grained earthy limestone containing only occasional fragments scattered through its mass. When there is just sufficient calcareous material to make a firm cement or bedding for the angular chert fragments, the rock is used for mill stones for which purpose it seems admirably adapted.

This bed of breccia points to a period of disturbance at the conclusion of the Knox dolomite epoch when the rocks already deposited were elevated sufficiently to suffer some local erosion with the redeposition of the more durable portions. No indication of unconformity appears between adjacent beds of dolomite and limestone, but in their present disturbed and poorly exposed condition, a slight unconformity would be extremely difficult to detect.

The largest areas of Chickamauga limestone are in the southern half of Browns valley and in West Chickamauga valley. In the former it is the oldest formation exposed, occupying the top of an anticlinal; in the latter it is the youngest, occupying a synclinal from which the higher formations, still seen in Pigeon mountain, have been removed. Aside from these comparatively broad areas, the Chickamauga limestone occurs only in narrow strips where the upturned edges of the formation border the various synclinals occupying the central and western divisions of the map area.

This limestone uniformly gives rise to valleys which usually lie between the chert hills on one side and the Rockwood shale or sandstone ridge on the other. It generally extends well up in the face of the ridge, protected from erosion by the overlying sandstone.

Rockwood Formation.—Sr. This formation includes all of the Silurian above the Chickamauga limestone; the Dyestone group, White Oak and Clinch mountain sandstone of Safford, and the Clinton, Red mountain or Dyestone of the Alabama survey.

In the northwestern portion of the area, the formation consists of from 600 to 800 feet of calcareous shales with thin beds of limestone and fossil iron ore. Toward the southeast it becomes less calcareous and more sandy. In Taylor's ridge it is about double the above thickness and appears as a series of thin bedded purple sandstones, corresponding to Safford's White Oak mountain sandstone. Still farther east in Chattoogata and Rocky Face, interbedded with shales above the red sandstone, are two heavy beds of white sandstone or quartzite. corresponding in lithologic character though probably not in stratigraphic position to Safford's Clinch sandstone. This change from the phase presented in Browns valley to that in Rocky Face, is a gradual one and doubtless with sufficient exposures individual beds could be shown to pass through all the intermediate varieties. It is exactly the change which would be expected to occur in passing from off-shore deposits to those comparatively near the source of supply from which the rock material was derived. While this change in lithologic character is most marked in passing across the strike, it is also noticeable along the strike. Thus in Johnsons Crook at the head of the Wills valley anticlinal the formation is very calcareous, while to the southwest on the same anticlinal at Atalla it contains much thin bedded sandstone. The same transition is seen in Taylors ridge. At its northern extremity, White Oak mountain in Tennessee, the formation consists largely of thin red sandstones, with shales toward the top containing a considerable bed of iron ore. Toward the southwest the shales and iron ore at the top disappear and the whole formation at the southern end of the ridge consists of heavily bedded reddish brown sandstone with some beds approaching quartzite in character. These lithologic changes indicate that the structure axes are not exactly parallel with the Silurian shore line, but that the latter had a more east and west direction than the present strike.

The Rockwood formation nowhere occupies areas of any considerable extent, but the aggregate area of its outcrops is not inconsiderable. The red iron ore which renders this formation so important in the southern Appalachian region, does not extend south of the Tennesse line in Taylors ridge and probably does not occur in any of the ridges east of Dirt Seller mountain. It is uniformly present to the west, though not always in quantities sufficient for profitable working. In the central division the formation occurs in narrow strips forming minor ridges along the sides of the valleys and parallel with the escarpments of Coal-measure sandstone. The ridges are produced partly by the rocks of this formation, but are due more to the resistance offered to erosion by the chert beds at the base of the Carboniferous. In the eastern division the Rockwood sandstone produces the ridges, the cherty beds being a subordinate factor.

Devonian Rocks.

Chattanooga black shale—Dc. The whole of the Devonian period is represented in Alabama and Georgia by a thin stratum, from eighteen to thirty five feet, of black, highly carbonaceous shale. This passes by a more or less gradual transition into the blue and yellow shales of the Rockwood formation below, while at the upper limit there is an abrupt passage to the Fort Payne chert forming the base of the Carboniferous. The upper bed of the Chattanooga, about three feet in thickness, is bluish gray shale, and usually carries at the top a layer of round concretions an inch or less in diameter.

Occurring between two ridge making formations, the black shale occupies a narrow strip along one side near the crest of the Rockwood ridges. It occupies this position in all except the extreme eastern ridges, where the formation appears to be wanting, the Fort Payne chert resting directly upon the Silurian sandstone

Carboniferous Rocks.

The rocks of the Carboniferous period are placed in the following six divisions, of which the two upper belong to the Coal-measures and the remainder to the sub-Carboniferous group, as defined by Smith and Safford. The name, Mississippian, has more recently been applied to this group of rocks by Prof. H. S. Williams and is much preferable to sub-Carboniferous. The four formations comprised in the Mississippian group in this region are not separated on the accompanying map, but are represented together by a single pattern in order to avoid confusion.

6. Walden sandstone; coarse sandstone, sandy shale, argillaceous shale or fire clay, and beds of coal.
5. Lookout sandstone; coarse conglomerate, sandstone and shale with beds of coal toward the north.
4. Bangor limestone; blue crinoidal limestone with nodules of chert, partly replaced toward the southeast by the two formations below.
3. Oxmoor sandstone; white or yellow coarse porous sandstone, occurring as lenses at the top of the following formation.
2. Floyd shale; black carbonaceous shale with beds of shaly limestone.
1. Fort Payne chert; cherty limestone with beds of massive chert at the base.

Fort Payne chert.—Cp. The lowest formation of the sub-Carboniferous or Mississippian group consists of highly siliceous limestone. Its name is taken from Fort Payne, Alabama, where it is typically developed. At the base of the formation are heavy beds of chert which become less massive higher up, and toward the top are replaced by more or less abundant isolated nodules. Sometimes the chert is almost wholly replaced by beds of porous sandstone. This change is specially marked toward the northeast.

The Fort Payne chert varies in thickness from two hundred feet in the southern portion of the field, to fifty or or less in the northeastern. The lower beds carry few fossils, but higher up they become very abundant and the rock frequently consists of a mass of crinoid stems imbedded in a siliceous cement. On weathering, the cement remains as a porous chert filled with fossil impressions.

The topographic value of the Fort Payne chert has already been described in discussing the relative efficiency of that formation and the Rockwood in the production of ridges.

Oxmoor sandstone.—Co.
Floyd shale.—Cf. The Fort Payne chert is followed by an extremely variable formation which has been named from its great development in Floyd county, Georgia. It consists in the eastern division of black or yellow shales with beds of limestone, and local developments of sandstone. In the central and western divisions it is much thinner and more calcareous, and only towards the south are the sandstones present. The Floyd shales contain a large amount of calcareous matter, either as beds of pure blue limestone or disseminated through the shales. The fossils are confined to the more calcareous portions and in these they are extremely abundant. As already stated, the formation becomes more calcareous toward the west and contains heavy beds of limestone below the Oxmoor sandstone which there forms its upper member.

The Oxmoor sandstone is variable in character and in its position in the formation. Toward the southwest it is a coarse, porous sandstone, white or yellow, occurring in heavy beds with few fossils. East of Taylors ridge there is a thin bedded, more compact sandstone, sometimes highly fossiliferous which passes gradually into the Floyd shales above and below. Indeed, these sandstones east of Taylors ridge may be regarded simply as a phase of the Floyd shales, and it is questionable whether they should be correlated with the Oxmoor sandstones occurring west of Browns valley.

Wherever the Oxmoor sandstones occur they exert a marked influence on the topography. In Texas and Dirt Town valleys they appear as low but distinct ridges lying between the higher elevations formed by the Fort Payne chert and Rockwood on one hand, and the escarpment of Lookout sandstone on the other. West of Browns valley and south of the Tennessee river, the Oxmoor sandstone forms a terrace part way up the steep slopes of the plateau. The

Floyd shales always give rise to valleys forming in the eastern division, a continuation northward of the broad, level Coosa valley "flatwoods." In the central division they are long and narrow, lying between the short ridges and the sandstone escarpment. The underlying rock is seldom exposed, being usually deeply covered by overplaced soil and rock débris from the formations on either side, especially from the Lookout sandstone.

Bangor Limestone.—Cb. The upper member of the sub-Carboniferous or Mississippian group consists in the main of pure blue limestone. Its greatest development is in the western division of the area, where it rests directly upon the Oxmoor sandstone; or where that is wanting as at Stevenson, Ala., the limestone extends without break down to the Fort Payne chert. It is equivalent to Smith's upper sub-Carboniferous, and very nearly to Safford's mountain limestone. The limestone is always highly fossiliferous, being made up almost entirely of fragments of Crinoid stems. A short distance, perhaps fifty feet, from the top it becomes very earthy and usually passes into bright colored clay shales. These beds mark the transition from a deep sea in which the limestone formed, to a shallow sea in which the mud, sand and pebbles of the formation above were deposited.

In the western division the Bangor limestone forms the slopes of the mesas already described in speaking of the topography of that section. The larger streams have cut down through this formation, but it still forms the bottoms and sides of the smaller valleys. Wherever the protecting cap of sandstone remains, the slopes are steep, rocky, and usually covered with a dense growth of cedar. Where the sandstone has been entirely removed, a gently undulating surface results. In the central division the Bangor limestone is found only in the steep mountain slopes. It is not, itself, a mountain producing formation, but owes its position to the protecting sandstone which overlies it. In the eastern division the formation is much thinner and greatly restricted in the area which it covers. It is only found skirting the few remnants of Lookout sandstone which have here escaped erosion.

The thickness of the Mississippian group as a whole, increases from the northwest to the east and south. At Stevenson, Alabama, it is not more than eight hundred feet in thickness. At Guntersville it is from eight hundred and fifty to one thousand feet. In the central division it increases from eleven hundred feet at Trenton, Georgia, to about fifteen hundred at the southern end of Lookout mountain. The Floyd shales of the eastern division are so highly contorted that their thickness can not be estimated with any degree of certainty, but this formation alone must be as thick as the whole group further west.

Walden Sandstone.—Cw. }
Lookout Sandstone.—Cl. } *Coal measures.*—While the lower portion of the Carboniferous period is represented by rocks which are prevailingly calcareous, the upper portion is represented by sandstones and shales with very little calcareous matter, indicating a marked and permanent change in the conditions of deposition at the end of the Mississippian era. The change was in the direction of shallower water and more abundant supply of mud and sand, conditions unfavorable for the animals whose remains go to form limestone. The surface also stood above sea level at various times, long enough at least for the luxuriant vegetation to flourish which has left its remains in the coal beds.

These sandstones and shales above the Mississippian group form the coal measures. They have been carefully studied by geologists of the Alabama Survey, especially McCalley and Gibson, and the coal beds which they contain have been so fully described that only their general stratigraphic relations will be mentioned here.

These rocks are divided in the present report into two formations, Lookout sandstone below and Walden sandstone above. The division is made at the top of a bed of conglomerate from ten to seventy feet in thickness which is a constant feature throughout the greater part of this field.

The Lookout sandstone consists of argillaceous shale or fire clay, sandy shale and sandstone with conglomorate at the top. The formation varies in thickness from about four hundred feet in Lookout mountain to less than fifty feet in Bristows cove, where the conglomorate rests directly on the Bangor limestone. In its thicker portions the Lookout contains at least two seams of coal which are in places of work able thickness, though not generally so.

Above the conglomorate are sandstones and shales with beds of coal and fire clay forming a series of rocks very similar to those composing the Lookout. These upper rocks, embraced under the name Walden, are more homogeneous than the Lookout and show marks of fewer abrupt changes in conditions of sedimentation. They contain most of the coal which forms so important an element in the wealth of northern Alabama. West of the Tennessee river only a few traces of conglomerate are found and the division between the Lookout and Walden becomes very uncertain.

While the greater part of Coal-measure rocks which originally covered the whole area have been removed by erosion, their present outcrops still occupy a much larger part of the surface than those of any underlying formation. In the western division, as already stated in speaking of the topography, mere remnants of a once continuous sheet of these rocks remain capping the summits of the mesas.

Of the central division at least three-fourths are covered by Coal-measures. The beds of conglomorate and associated heavy sandstones usually form a vertical cliff which is a prominent feature in the plateau escarpments, and an almost impassible barrier about the edges of Sand and Lookout mountains and the mesas west of Brown's valley. The Walden sandstone lying above the conglomorate occurs in the synclinals of Sand and Lookout mountains.

In the eastern division there are three very limited areas of Coal-measure rocks. These are fragments which have been protected from erosion by their position in the lowest portions of the Taylors ridge synclinal. They are of great interest as proving beyond question that the Coal-measures originally extended in a continuous sheet over the whole area. Thus they afford a measure of the thickness of strata eroded, especially in the eastern division, since the region was elevated above sea level.

The marked difference in the character of topography produced by the Coal-measures on the one hand and the Rockwood formation on the other, is due to the relation which the two sets of rocks ordinarily hold to a horizontal plane. The Rockwood sandstones usually dip at steep angles and so produce sharp ridges. The Coal-measure sandstones, on the other hand, are usually horizontal or have low dips, and produce forms of topography approaching the plateau type. In a few cases, the topography of the two formations is reversed. Thus, in the northern end of Dirt Seller mountain, the horizontal Rockwood forms a small plateau, while toward the southern end of Sand mountain, and in the southern end of Lookout mountain, the highly inclined Coal-measures form sharp monoclinal ridges.

VI. STRUCTURE.

Folds.

General Relations.—In the region under consideration the rocks whose beds now stand at all possible angles with the horizon, were originally horizontal or nearly so. They were deposited in broad sheets of sand or mud over the bottom of a sea which covered the greater part of the Mississippi valley, having its eastern shore a little to the eastward of the present great Appalachian valley. Since their deposition, the strata have been subjected to compression in a northwest and southeast direction so that the beds originally horizontal are now crowded into a series of folds. If the rocks which have been removed by erosion were restored, a fluted surface would be presented, formed by parallel arches and troughs extending in a direction at right angles to that in which the compression took place. The accompanying map covers but a very small part of the area occupied by these folded strata in the Appalachian province. They form a narrow belt extending toward the northeast through Tennessee, Virginia and Pennsylvania, and southwest toward middle Alabama.

The forces which caused these folds acted in such a manner as to produce the greatest results in the beds which were deposited near the shore. On the southeastern edge of the compressed belt, east of Chattooga valley on the map, the folds are closely crowded together and no considerable areas of horizontal rocks remain. In the central portion between the Tennessee and Chattooga rivers these folds are further apart, their sides have gentler slopes, and the beds are still horizontal in the troughs. On the extreme western edge the force appears to have spent itself, and the strata retain very nearly the horizontal position in which they were originally deposited. They have been raised to a higher level with reference to the sea and slightly warped but are without sharp folds.

Definition of terms.—In describing these folded strata the term synclinal is applied to the trough, and anticlinal, to the arch. A synclinal axis is a line running lengthwise of the synclinal trough, at every point occupying its lowest part and toward which the rocks dip on either side. An anticlinal axis is a line occupying at every point the highest portion of the anticlinal arch, and away from which the rocks dip on either side. These axes may be horizontal or inclined. Their departure from the horizontal is called the pitch of the axis and is usually but a few degrees.

The anticlinal folds of the southern Appalachians are rarely symmetrical for the rocks usually dip away from the axis much more steeply on one side than the other. The accompanying section, figure 5, across Lookout mountain and Wills valley to Sand mountain, shows the typical anticlinal and synclinal fold of this region. The dotted lines represent the form which the strata would have if all the rocks removed by erosion were restored; while the heavy lines represent beds which remain, and the present land surface. *S* and *A* indicate the positions of the synclinal and anticlinal axes.

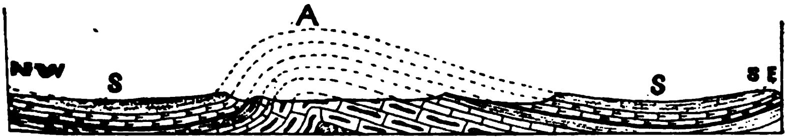

Figure 5. Section through Lookout mountain, Wills valley and Sand mountain; showing the normal form of *unsymmetrical anticlinal fold* with steep dips on the north-western side.

It is to be observed that the steeper dips are along the northwest side of the anticlinal axis. This is the general rule to which there are but two exceptions within the map area. These exceptions are in Bristows cove, at the head of Murphrees valley, and at Rising Fawn, at the head of Wills valley. In these two cases the steeper dips are on the east side of the anticlinal axes. The latter of these exceptions is only local, and the anticlinal assumes its normal form a few miles to the southward. The Murphrees valley anticlinal, however, has the steeper dips on the eastern side of the axis to its extreme southern end.

Structure of the Western Division.—As already stated in describing the topographic features, the strata west of Browns valley are practically horizonal. This region has, therefore, the simplest possible geologic structure. This is shown in the left hand portion of the structure section which accompanies the map. It must not be understood that the horizontality is absolute, for the sediments were not laid down on a perfectly level surface, and the lifting to their present position has been accompanied by slight warping of the beds and a general tilting to the southwest. These deviations from the horizontal, however, are small and scarcely to be detected except by following the same bed for a long distance.

Folds of the Central Division.—The first marked disturbance of the rocks met with in coming from the northwest along the line of the structure section is at the western edge of Browns valley where the strata are sharply upturned and in some places broken by a fault which will be described later. Passing Browns valley the rocks which form its steep and frequently precipitous eastern border are found to dip from 5° to 8° to the southeast, forming the western edge of the Sand mountain synclinal. This escarpment extends in a nearly straight line across the map, with a trend of N. 40° E. Turning 10° more to the north about the Tennessee line, it extends for sixty-five miles further as the western escarpment of Waldens ridge facing upon the Sequachee valley. These are the structural continuations, respectively, of Sand mountain and Browns valley. The southwestern extension of this escarpment beyond the map area is only eight or ten miles to the vicinity of Blountville, where it loses its distinctive character. Its entire length is thus about 150 miles. The escarpment is not continuous throughout this distance for numerous streams flowing from the broad top of Sand mountain have cut canyons back some distance from the edge, forming deep notches in the cliff line.

Throughout the greater portion of the map area Sand mountain extends as a single broad synclinal but in both the southern and northern portions it is more complicated. Thus in the southwestern corner of the map the synclinal is divided into two distinct synclinals by the northern end of the Murphree valley anticlinal. This latter extends seventeen miles from the edge of the map, where it disappears, and north of this point the two synclinals merge in one. Of these two synclinals the one to the west is broad and shallow, while that to the east, lying between Bristows cove and Greasy cove, is narrow and the strata forming its sides dip steeply toward the center. The latter continues southwestward as the Blount mountain synclinal. Instead of forming a flat topped mountain as is ordinarily the case, the Coal-measure sandstones are here bent down to the valley level in the center of the synclinal, while along its edges they form high, sharp, monoclinal ridges. A similar break in the regularity of the Sand mountain synclinal occurs where it crosses the Georgia--Alabama line. The relations of the folds in a small area embracing portions of Sand and Lookout mountains with the adjacent valleys is shown in figure 6. The heavy lines extending in a northeast and southwest direction indicate the position which the axes of the folds occupy. The arrows show the direction in which the strata dip and the lines toward which they point are synclinal axes, while those away from which they point are anticlinal axes.

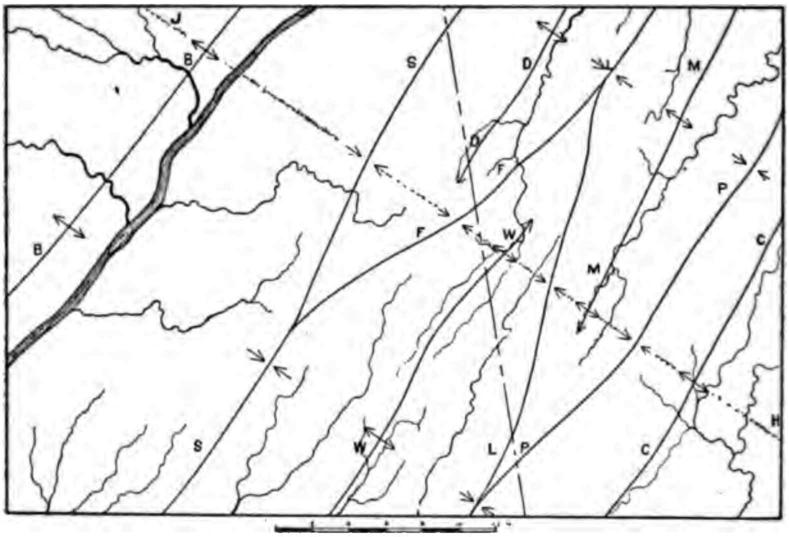

Figure 6. Outline map of a portion of the region between Chattooga valley and Browns valley; showing the relation of *synclinal* and *anticlinal axes*. Arrows indicate the direction in which the strata dip. B B indicates the position of the Browns valley anticlinal axis; S S Sand Mountain synclinal; D D Deerhead cove anticlinal; F F Fox Mountain synclinal; W W Wills valley anticlinal; L L Lookout Mountain synclinal; M M McLamores cove anticlinal; P P Pigeon Mountain synclinal; and C C Chattooga valley anticlinal axes.

The Lookout valley anticlinal D D, figure 6, coming in from the north terminates in Deerhead cove, very much as Murphrees valley does in Bristows cove. It divides the Sand mountain synclinal into two, a very broad one on the west and a narrow one on the east. The latter forms Fox mountain just west of Rising Fawn. The axis of the Fox mountain synclinal, F F, figure 6, continues toward the northeast as the axis of the northern part of Lookout mountain, L L figure 6. The overlapping ends of the three anticlinals, DD, WW, and MM, figure 6, give rise at this point to a series of four synclinals, SS, FF, LL, and PP, figure 6, arranged in a zigzag fashion like the letter **W**. The structure section, figure 7, further illustrates the relation of the folds along the dotted line in figure 6, at right angles with

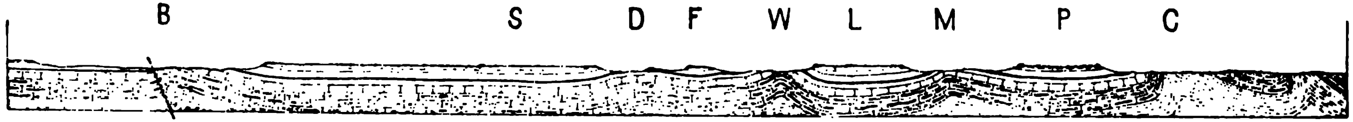

Figure 7. Section from Chattooga valley to Browns valley along the line J H in figure 6; showing the relation of *synclinal* and *anticlinal axes*. B indicates the position of Browns valley anticlinal axis; S Sand Mountain synclinal; D Deerhead cove anticlinal; F Fox Mountain synclinal; W Wills valley anticlinal; L Lookout Mountain synclinal; M McLamores cove anticlinal; P Pigeon Mountain synclinal; and C Chattooga valley anticlinal axes

the axes. The position of the latter are indicated by the same letters used for corresponding axes in figure 6. The section shows the three overlapping anticlinals as described above and the four resulting synclinals which form Sand, Fox, Lookout and Pigeon mountains, lettered respectively S, F, L and P.

The narrow Fox mountain synclinal between Johnsons Crook and Deerhead cove has been cut through by the waters of Lookout creek, so that Wills and Lookout valleys appear to be continuous, but structurally they are entirely distinct.

Lookout mountain lies almost wholly within the map area, terminating about a mile north of its northern limit. Its southern end is cut sharply off by a fault running from Gadsden to Attalla. At this point the synclinal is sufficiently deep to bring the Walden sandstone down to the level of the Coosa valley. The strata in the upturned edges of the synclinal form high ridges, steep on the outer side and sloping gently within toward the center. The axis rises gradually toward the north and the dips becoming less steep the two ridges coalesce and form the level topped mountain which is its prevailing character throughout the greater part of its length. From the southern end, the synclinal gradually increases in width toward the north from about two miles, at Gadsden, to nine, where it crosses the Alabama-Georgia line. At this point the synclinal is divided into two by the anticlinal of McLamores cove; the eastern axis, continuing in line with the southern part of the mountain, runs through Pigeon mountain, while the western, bending slightly toward the north unites with the axis of the Fox mountain synclinal and forms the northern end of the mountain which terminates abruptly in Lookout point just south of Chattanooga.

Folds of the Eastern Division.—Between Lookout mountain and the Oostanaula-Coosa river a number of synclinals and anticlinals occur. They are less regular than those already described and the folds are more closely crowded together. Along the western side of the anticlinal axis the strata are frequently overturned and faulting is a much more important factor than in the central division.

The rocks which here resist erosion and so form the high ridges are no longer the Walden and Lookout sandstones, but belong to the Rockwood formation in which, as already described, the proportion of sandstone to shale and limestone increases rapidly toward the southeast.

First north of the Coosa river are the Dirt Seller mountain and Gaylors ridge. These are both synclinals terminating in abrupt spoon-shaped points toward the north. From these high points the sides of the synclinals diverge toward the southwest, the axes pitching down in that direction. On the south they are sheared off by faults which cut across at angles from 45° to 60° with their axes. In each case a triangular area is thus included by the two arms of the synclinal and the fault.

East of the Chattooga valley lies Taylors ridge extending a long distance northward into Tennessee, where it is called White Oak mountain. This ridge, so remarkable for its uniformity in elevation and trend, forms the western side of a synclinal whose eastern edge is very irregular and in many places entirely absent by reason of faulting.

This synclinal is not a smooth, regular trough like those already described but is broken up into a number of small basins by anticlinal folds which cross from one side to the other. Thus Dirt Town valley and West Armuchee valley are separated by a ridge transverse to the main synclinal axis. In the gap cut through the ridge by Ruff creek, its anticlinal character is perfectly shown. A similar transverse anticlinal separates Houston valley from the northern portion of the synclinal. Dirt Town valley and Texas valley may be regarded as parts of the same synclinal, separated as described above by a transverse anticlinal. In this case, however, the anticlinal has been lifted higher and a valley eroded for some distance along its axis. Thus it is similar to the other cases, but carried to a further stage of development. This transverse anticlinal forms Simms mountain but does not pass entirely across the synclinal as in the other cases, the axis pitching down and dying out before reaching the eastern side. In a similar manner the axes of Lavender mountain coming from the southwest and Johns mountain from the north, pitch down and carry the ridge-making sandstones below the valley level. There is thus formed a natural gateway for the passage of the streams draining the interior of the synclinal basins and through this flows Armuchee creek.

East of the above described synclinal is a series of four overlapping ridges, each one advancing a few miles further to the northward than its western neighbor. They are formed by the zigzag outcrop of a fluted surface, the axes of whose folds pitch toward the south. The northern ends of the ridges are all synclinal, though by the lesser prominence of the eastern sides of the synclinals they appear to be monoclinals dipping to the southeast. Thus the western side of a synclinal and its continuation south as the eastern side of an anticlinal forms Johns mountain. Horn mountain has the same structure, except that it terminates to the south in two anticlinals. Mill creek and Chattoogata mountains are but repetitions of the structure seen in the others.

Excepting the region about Weisner and Indian mountains the structure southeast of the Oostanaula-Coosa river is comparatively simple. The greater part of this area is occupied by a broad gently undulating synclinal composed chiefly of Knox dolomite. Radiating from Rome with a fan-like arrangement a number of minor folds along the western edge bring the underlying Cambrian shales to the surface. The axis of this broad synclinal pitches gently to the southeast and in the corner of the map the rocks appear which overlie the dolomite, namely, Chickamauga limestone and Rockmart slate. This synclinal extends only a few miles east and south of the limits of the map to a fault which marks its contact with the semi-metamorphic rocks. The Knox dolomite in this region is extremely massive and the force which in other places compressed the strata into close folds here produced only gentle undulations.

A small area in the vicinity of Weisner and Indian mountains shows greater complexity of structure than any other portions of the map area. The complexity, however, is produced rather by faulting than folding, and the region will be described later.

Faults.

Definition and Classification of Faults.—In most regions where the strata are elevated to any considerable extent above the position in which they were originally deposited, the process of elevation has been accompanied by more or less fracture. Such fractures are called *faults* when the rocks have slipped past each other on opposite sides, and the plane on which the slipping takes place is called the *fault plane*. The angle at which a fault plane intersects the vertical is called the *hade*, and the amount of vertical displacement which any bed suffers is the *throw* of the fault. In regions whice have simply been elevated without lateral compression, faults, almost without exception, hade to the downthrow; that is, the fault plane dips under the rocks which have been relatively depressed. This is usually called the *normal fault*. The accompanying ideal section, figure 8, illustrates the simplest form of the normal fault. The arrows indicate the direction in which the strata on opposite sides of the fracture have been moved, and the line, FF, which indicates the position of the fault plane, dips under the rocks which have been depressed. It will be seen by consideration of the section that the lateral extent of the rocks is greater after than before the faulting, and hence we should not expect to find this taking place as the result of

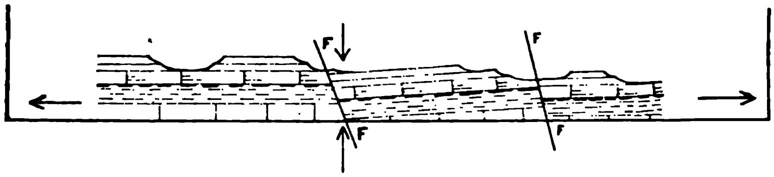

Figure 8. Ideal section through flat strata; showing the character of *normal faults*. The fault plane F F dips under the strata which have been relatively *depressed*.

lateral compression, the effect of which is to crowd the rocks into smaller space than they originally occupied.

In describing the Appalachian folds it was shown that they are usually unsymmetrical, the dips being steeper on one side than on the other. In the formation of such a fold, when the rocks on the steeper side of the anticlinal become nearly vertical, a plane of weakness is developed along which fracture is especially liable to occur. This plane cuts across the strata on the steeper side of the anticlinal and is inclined so as to be nearly parallel with the gentler dips on the other. If the lateral compression which produced the fold is continued, a break may occur along this plane of weakness. Such a break is called a *thrust fault*, and is peculiar to compressed regions like the one under discussion. The hade of such a fault is always toward the up-throw; that is, the fault plane, T T, figure 9, dips under the rocks which have been relatively elevated. Hence, the lateral extent of the strata is less after than before the faulting. These thrust faults always occur on the steep side of the anticlinal and since this is generally on the west side, so most of the faults of this region are on the west side of anticlinals and the east side of synclinals.

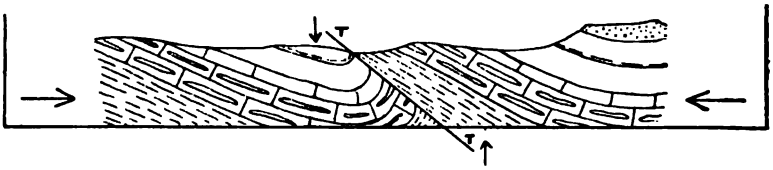

Figure 9. Ideal section through folded strata; showing the character of *thrust faults*. The fault plane T T dips under the strata which have been relatively *elevated*.

Thrust faults may be classed, for convenience of description, in two groups according to the angle of hade; (1) those in which the fault plane makes an angle of less than 45° with the vertical, and (2) those in which it approaches the horizontal. The first group in which the fault plane is rather steep comprises the larger number but the same fault, in different portions may belong to both. There is no essential difference between the two, both being produced by the same forces acting under slightly different conditions.

The *over thrust* or *displacement* is the distance between the broken edges of any stratum on opposite sides of the fault plane or the distance through which the rocks have been pushed on the fault plane. It may be slight, only sufficient to conceal a few beds of rock, or it may be very great, so as to completely obliterate the steep side of the contiguous synclinal and anticlinal, and leave the gentler dipping sides of two anticlinals resting conformably one upon the other. The greatest displacement is found in faults which have their fault planes nearly or quite horizontal. In these the displacement is sometimes several miles.

The *stratigraphic displacement* is measured by the thickness of the strata which normally occur between beds brought by the fault into contact at the surface. For example, if a fault should bring the base of the Knox dolomite in contact with the top of the Chickamauga limestone the stratigraphic displacement would be equal to the combined thickness of Knox and Chickamauga or about 4,700 feet. Like the overthrust, this stratigraphic displacement is variable in amount. In some cases it involves only part of a single formation, and in others where the oldest and youngest formations are in contact it is measured by the combined thickness of the whole stratigraphic column, amounting to many thousand feet.

Wills Valley Faults.—Some excellent examples of thrust faults are found in Wills valley and one of the most typical will be described in detail. Wills valley has already been described as a long, narrow, deeply eroded anticlinal lying between the broad, shallow synclinals which form Sand and Lookout mountains. Except for a short distance at its northern end it has the normal form of an unsymmetrical arch with the steep side to the northwest. The dips are from 10° to 18° on the southeast and 75° to 90° on the northwest sides of the arch. At various points along the western side of this normal anticlinal are found thrust faults of greater or less extent.

It may be well to indicate briefly how the presence of a fault is determined in the field. It must not be imagined that where the strata have been thrust up hundreds or thousands of feet on one side of a fracture, the surface remains higher than on the side where they have been relatively depressed an equal amount. Erosion has planed down the surface so that all the inequality produced by faulting is obliterated. Indeed, it is not probable that the difference in elevation on opposite sides of the fault line was at any time very great. The probability is rather that the process was so extremely slow, consisting of so many small slips distributed over so long a time, that erosion kept pace with elevation and the two processes balanced each other. Nor is it often possible to detect the plane on which the slipping took place, although it may sometimes be seen, especially when the displacement is slight. The ordinary evidence of a thrust fault is the finding of formations in contact which are normally separated by a greater or less thickness of intervening strata. Hence a fault is more marked the greater its stratigraphic displacement since more widely separated formations are thus brought in contact at the surface.

Thus, to return to Wills valley, there is a regular sequence in the formations and topographic features in passing from the center to either side wherever the anticlinal holds its normal form undisturbed by a fault. This sequence is the same on both sides of the axis. The center of the valley is occupied by a strip of Knox dolomite forming low rounded hills composed of chert and residual clay. On either side of this central dolomite belt is a strip of Chickamauga limestone forming a narrow valley. The Rockwood formation, the Chattanooga black shale and the Fort Payne chert next form a pair of ridges. Outside these ridges the Floyd shales and the lower portion of the Bangor limestone determine valleys; and finally are the opposing cliffs of Lookout sandstone. The order in which the formations occur is identical in passing either way from the central belt of dolomite. But the topography is not precisely symmetrical since the strips of each formation are narrower on the west side of the axis than on the east, for a given thickness of rocks occupies a narrower space at the surface with steep than with gentle dips, and so the want of symmetry in the fold produces a corresponding want of symmetry in the surface distribution of the several formations. It is found, however, at certain points, as at Sheffield Gap on the line of the Coosa and Tennessee railroad, that while this regular sequence holds for the eastern side of the valley it does not for the western. One or more of the formations disappear for a short distance so that the outcrops of the overlying and underlying formations come in contact. There is no invariable rule as to the order in which the formations disappear, though it is most common to find the dolomite encroaching upon the higher formations and successively overlapping them from the lowest up. First the valley of Chickamauga limestone disappears, the dolomite coming in contact with the Rockwood shale ridge. Next, the ridge disappears, then the valley back of it, and finally the dolomite is found thrust against the upturned edge of the Lookout sandstone. An inspection of the following sections will show the relation between the thrust fault and the successive disappearance at the surface of the several formations. Figure 10 is a section through the anticlinal, showing its normal form. In this the sequence of formations on either side of the axis is the same. Figure 11 represents the anticlinal fold at a point where the fault has begun and the thrust is sufficient to hide only a single formation. The dolomite rests upon the broken edges of the Chickamauga limestone and at the surface comes in contact with the next higher formation, the Rockwood shale. The next section, figure 12, shows the same fault at a point where it has attained its maximum displacement. The dolomite here overplaces and hides all the formations below the Lookout sandstone against the upturned edge of which it is seen to lie.

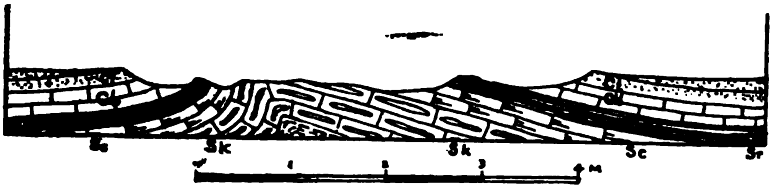

Figure 10. Section across Wills valley near Fort Payne; showing the *normal unsymmetrical anticlinal fold.*

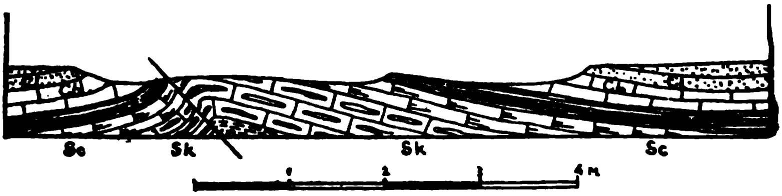

Figure 11. Section across Wills valley three miles north-east of Collinsville; showing a *thrust fault* by which the Chickamauga limestone Sc on the western side of the valley is concealed.

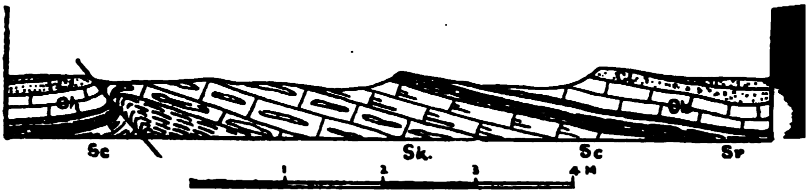

Figure 12. Section across Wills valley three miles south-west of Collinsville; showing a *thrust fault* by which all formations between the Knox dolomite Sk and the Lookout sandstone Cl on the western side of the valley are concealed.

Since the fault plane is not exactly parallel with the axis of the anticlinal its relation to the beds is variable and it may cut them so that the Chickamauga limestone or the Rockwood shale may be the formation which shall overlap the higher ones. Thus, at Rodentown, the Chickamauga is thrust over upon the Lookout sandstone, overlapping the Rockwood shale, the Fort Payne chert, and the Bangor limestone. And at Belcher Gap the Rockwood shale overlaps the Fort Payne chert and the greater part of the Bangor limestone.

An understanding of these faults is of the highest importance to the prospector since to them is due the occasional complete disappearance of the iron bearing Rockwood formation in this and similar valleys of northern Alabama.

The faults which occur at intervals along the western side of Wills valley have most of the essential characteristic of the southern Appalachian thrust faults, but they are insignificant in extent and in the amount of displacement, compared with those further east.

Taylors Ridge Fault.—The synclinal of which Taylors ridge forms the western edge is cut off by a fault along nearly the whole of its eastern side. Portions of the eastern limb of the synclinal remain, but in these the rocks are vertical or slightly overturned. From Woods gap northward the fault is continuous, bringing the Cambrian at different points against each of the overlying formations up to the Carboniferous. Only the southern end of this fault is within the map area, but it extends toward the northeast entirely across Tennessee and well into Virginia, a total distance of about three hundred miles.

Rome Thrust Fault.—Another fault extends two hundred miles to the northeast, parallel with that above described. It enters the map area near its northeast corner, and follows along the east base of the Rocky Face and Chattoogata mountains, shearing off the eastern side of those synclinals and bringing the Cambrian against the upper Silurian and Carboniferous rocks. A section, figure 13, through Chat-

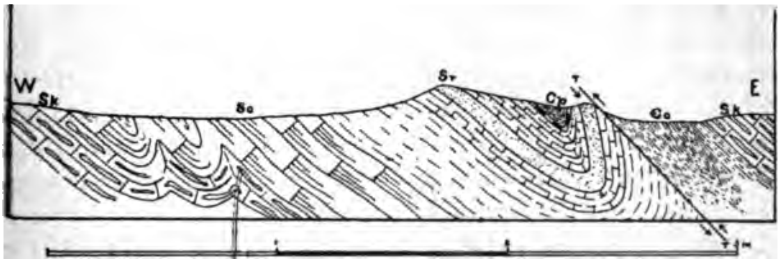

Figure 13. Section through Chattoogata mountain four miles south of Buzzard Roost gap; showing the position of the *Rome thrust fault* indicated by the line T T.

toogata mountain four miles south of Buzzard Roost gap, shows the nature of the fault at this point. While the hade of the fault as indicated in the section is hypothetical, being placed at 45°, there is a fair degree of probability that this represents its actual position. A consideration of the mechanism of the thrust fault indicates at least that this is the position of a plane on which there is the greatest liability for fracture to take place, and that the fault plane must have nearly the same dip as the strata in the unbroken limbs of adjoining anticlinals. Also, if the fault plane were vertical its trace upon the surface would not be influenced by elevations and depressions, but would be approximately straight. On the other hand, if the thrust plane approached the horizontal its outcrop at the surface would be rendered extremely devious by these surface inequalities. Hence the hade of a fault may be determined, within certain limits, by its line of outcrop when platted upon the map.

The fault above described as following the eastern base of Chattoogata mountain extends a long distance to the southwestward, but with a decided change in character which places it in the second group. In these the plane on which the motion took place approaches nearly or quite to the horizontal. This remarkable fault has already been somewhat fully described by the writer under the name of the "Rome thrust fault."*

From the southern end of Chattoogata mountain to Coosaville the stratigraphic displacement is sufficient to bring Cambrian in contact with Carboniferous rocks. The contact is marked by no topographic feauture and the discrimination of the two shale formations is at first difficult. Careful search, however, always reveals the presence of Cambrian fossils in the Coosa, while the presence of more or less carbonaceous matter serves to distinguish the Floyd shale. Occasional beds of highly fossiliferous limestone in the latter remove all doubt as to its Carboniferous age. The line of contact between the Coosa and Floyd shales is extremely irregular, but it has been traced with considerable care and accurately located at a large number of points. All along this irregular line the Floyd shale everywhere passes under the Coosa, so that the long arms of Coosa which extend westward from the main body of the formation undoubtedly rest upon the Floyd, and a consideration of the relation which they sustain to the structure of the underlying strata explains their peculiar distribution. The structure of the region lying immediately west of the fault line between Taylors ridge and the Oostanaula river has already been very briefly described. The strata have been thrown into a number of folds so as to form an irregular corrugated surface with a generel pitch toward the southeast. The anticlinal axes north of Armuchee creek, for a short distance at least, trend northwest and southeast while those to the south trend northeast and southwest. Among the anticlinals belonging to the northern group are Chattoogata mountain, Sugar ridge, East and West Horn mountains, and Johns mountain; the axes of which all pitch toward the southeast. In the southern group are Lavender mountain, Beech creek, and Horseleg mountain anticlinals, with axes pitching toward the northeast. Ridges are formed wherever these anticlinals bring hard beds, as the Fort Payne chert and Rockwood, above the level of the Coosa river, but where only the soft Floyd shales reach this level they are planed down to a smooth surface and give no indication by elevations of the folds which are present. Thus the Horseleg anticlinal brings the hard beds far enough above the river to produce a prominent ridge while the Beech creek anticlinal lying to the west is not marked by any considerable surface elevation.

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*The overthrust Faults of the Southern Appalachians. Bull. Geol. Soc. Amer. Vol. II., 1891, p. 141

Returning now to the distribution of the Coosa shales an inspection of the map shows that to the eastward of Lavender and Johns mountains each synclinal trough bears an arm of Coosa in its lowest part. Thus the narrow synclinal lying between the Horseleg and Beech creek anticlinals holds a long narrow strip of Coosa shales, while a broader belt occupies the synclinal between Beech creek and Lavender anticlinals. In short the distribution of the rocks over this considerable area suggests almost perfect stratigraphic conformity between middle Cambrian and middle Carboniferous, *the Cambrian being on top.* The accompanying section, figure 14, from Rome northwestward to Texas valley, will serve to show more fully the relations which the Cambrian and Carboniferous rocks bear to each other. Beginning with the Knox dolomite east of the city and passing toward the northwest the formations underlying the dolomite are passed, the Connasauga shale, Rome sandstone, and Coosa shale, all dipping to the southeastward. But after passing a narrow strip of Coosa the Floyd shale is found dipping also to the southeastward, apparently conformable with the Cambrian and Silurian formations above. On the western side of the Horseleg mountain anticlinal the Floyd dips toward the northwest passing under a narrow area of Coosa which occupies the synclinal trough between Horseleg mountain and Beech creek anticlinals Beyond the latter the Floyd dips again toward the northwest passing beneath a second and broader arm of Coosa which lies in the synclinal between the Beech creek and Lavender mountain anticlinals.

The present relation of these formations is manifestly the result of a fault by which the older beds were thrust over from the east upon the younger on a plane which coincides approximately with the bedding. This thrust plane is represented in the section, figure 14, by the heavy broken line TT. It is not a plane surface as it probably was originally, but since the faulting it has been thrown into a series of gentle folds. The greater part of the overthrust strata have been removed by erosion which has reduced the surface of both Cambrian and Carboniferous shales to the base level of Coosa river. Their line of contract as shown on the map is therefore the intersection of an undulating thrust plane with the horizontal base level plane. Wherever the folding subsequent to the displacement has brought the thrust plane below the present base level, that is in the synclinals, there

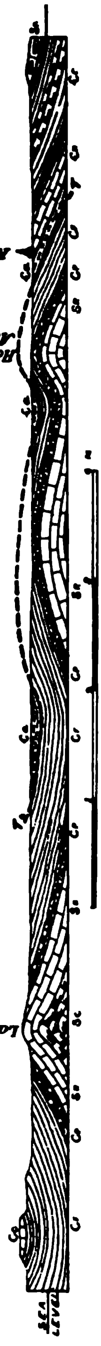

Figure 14. Section from Rome north-west to Texas valley; showing the relation of the Cambrian shales Ca to the underlying Carboniferous shales Cf. The line T T indicates the position of the *Rome thrust fault* plane on which the older rocks have been thrust over from the eastward upon the younger.

the overthrust rocks remain, while those at higher levels upon the anticlinals have been entirely removed. If the surface of the Coosa valley were lowered only a few hundred feet it is probable that all the Cambrian shales would be removed from the shallow synclinals in which they lie.

The distance through which the older strata have been moved westward over the younger by this thrust fault is between four and five miles and there is reason to believe that the Cambrian rocks once extended several miles further westward than they are at present found.

West of Coosaville the fault continues to Round mountain with much the same character except that the northwestward prolongations of the Cambrian shale are not so extensive as those above described. The reason for this is that the axes of the folds north of the fault pitch toward the southeast very rapidly and hence do not afford extended shallow synclinals in which the Coosa shales might remain protected from erosion.

Between Coosaville and the Alabama line one small area of Coosa shale occurs wholly isolated from the main body and lying upon beds which occur near the top of the Knox dolomite. In this case it is evident that the connecting shales have been removed by erosion leaving this small area protected by its position in a basin of Kxox dolomite below the level of Coosa river.

From Round mountain southwest to Gadsden the fault line follows approximately parallel with the eastern edge of Lookout mountain. Since the intersection of the thrust plane with the present land surface is nearly a straight line, a comparatively steep hade for this portion of the fault might be inferred, but that it is even here a broad overthrust is shown by the presence, five miles east of Gadsden, of a small area of Knox dolomite. This isolated area is wholly surrounded by Cambrian shale which appears to have been thrust over the dolomite from the eastward. Afterwards the overthrust Coosa was eroded through at this point down to the rocks lying below the thrust plane. The continuation of the Rome fault southward beyond Gadsden has not been studied in detail. It is probably replaced by several faults of the east Tennessee type which shear off the eastern sides of the Cahaba and Coosa Coal fields as shown by Squire and McCalley.

With the exception of the Rome thrust fault all that have thus far been considered are in a general way parallel to the strike of the rocks. The faults with steep hade seldom cut across the beds, or when they do it is only for a short distance and at a very slight angle with the strike. They may be termed strike faults. This parallelism between the lines of fracture and the anticlinal axes permits the former to extend for long distances as above described, with a constant relation to the same folds.

Transverse Faults.—An inspection of the map will show that on a line between Rome and Atalla there is a sudden transition in structure. The structural axes, which on the north of this line trend north 10° to 30° east, are abruptly terminated by an axis running nearly east and west. This sudden change in direction of strike gives rise along this line to a series of transverse faults as rare as the peculiar conditions by which they are produced. The three faults which come under this class are those terminating the Gaylors ridge, Dirt Seller mountain and Lookout mountain synclinals. In every case the northern ends are strike faults of greater or less extent along the east side of the synclinals. Approaching the Coosa valley which marks the east and west axis above mentioned, they abruptly change their course, swinging sharply around to the west. After crossing the synclinal they die out in the anticlinal beyond. The faults terminating both Gaylors and Dirt Seller synclinals pass beneath the plane of the Rome thrust for short distances. It seems probable that in this region considerable folding, faulting and erosion was accomplished before this thrust and that the present complicated relations of the strata were produced by at least two periods of intense compression separated by a period of comparative rest.

The most remarkable of these transvere faults is the one which terminates the Lookout mountain synclinal. Between Gadsden and Atalla the east and west axis turns sharply toward the southwest, continuing down Canoe Creek valley. It thus results that the Canoe creek anticlinal and the Lookout synclinal come together, end to end. Such a relation between a downward bending trough and an upward bending arch necessitates an enormous shear where the two come together. And this is exactly what has taken place along the line between Gadsden and Atalla. The friction of the strata in slipping past each other has bent their edges at an abrupt angle near the fault plane; the Lookout sandstone on the side which went down is turned up into a vertical position and forms a distinct ridge along the northern side of the fault line. In contact with this on the south are the downward flexed Coosa shales. This bending of the strata by the drag of the fault is represented in the section, figure 15, which crosses the fault at right angles.

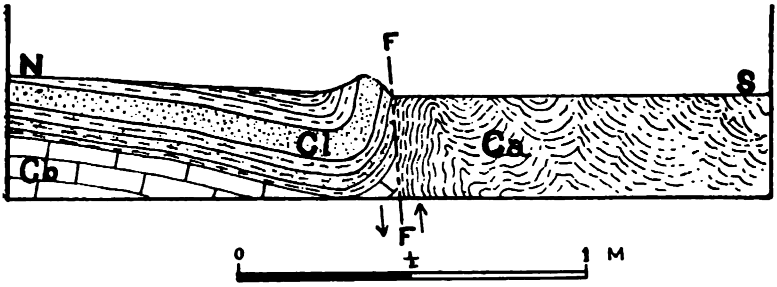

Figure 15. Section north and south along Black creek; showing the position of the *transverse Gadsden-Atalla fault.*

The slipping plane of the Gadsden-Atalla fault is probably very nearly vertical, or it may dip under the depressed beds. Being transverse to the line of cempression this would not be improbable. It might, therefore, be classed as a normal fault, in accordance with the definition already given, except for its very intimate relations with the thrust faults of the region.

Faults of the Weisner Region.—As already stated, there is a small area lying between Weisner and Indian mountains which has a peculiar and extremely complicated geologic structure. It would require a detailed map of this region on a large scale with numerous sections to adequately represent the structure but this detailed statement is not practicable in the present report. Only the general conclusions can be given here.

Weisner and Indian mountains are monoclinal ridges formed by heavy beds of Weisner quartzite which occur interbedded with the Rome sandstone and shales. They present toward the northwest steep and rugged faces formed by the broken edges of the quartzite beds while the southeastern sides have a more gentle slope with the dip of the strata. The region between these two main ridges is occupied by a number of subordinate ridges somewhat irregular in their arrangement but in general parallel among themselves and extending in a direction more nearly north and south than the main ridges. These subordinate ridges are composed for the most part of Knox dolomite and Rockwood sandstone, while the intervening valleys are underlain by Chickamauga limestone and shale.

A belt of Knox dolomite extends along the northwestern side of the complicated area in a northeast and southwest direction parallel with Weisner and Indian mountains. This belt is composed of a number of short ridges extending nearly north and south and slightly overlapping; that is, each ridge extends a little further north than the next one to the westward. A similar belt of Rockwood sandstone ridges lies to the southeast parallel with the dolomite belt though it is not so continuous or regular as the latter. The region has aparently passed through the structural stage in which the strata occupy simple folds or even folds accompanied by faults parallel with the axes, though some traces of the folds still remain. Thus the Knox dolomite belt above discribed was aparently the northwestern edge of a synclinal which occupied the region between Weisner and Indian mountains. The later formations which mark the axis of the synclinal form an irregular belt passing through Rock Run. This synclinal has been almost wholly obliterated by a series of faults which extend nearly north and south, cutting across its axis at an angle of about 45°. By these faults the strata have been broken up into a number of blocks and the blocks of strata have been slid over upon one another so that they now overlap like the shingles of a roof. Each of the subordinate ridges which make up the belt of Knox dolomite, is composed of a block of strata separated from adjacent ridges by faults. The same is true of the sandstone ridges which form the corresponding belt toward the southeast.

What the conditions were which produced this peculiar structure can only be conjectured, but they seem in some way connected with the transverse faults on the opposite side of Coosa valley. Both sets of phenomena at least appear to be due to the action of similar forces, and there are indications that in both cases the faulting took place after the original folds had suffered considerable erosion.

The faults, by means of which the blocks of strata are shingled up one upon another, have been traced only to the edge of the dolomite belt but it is altogether probable that they extend much further into the Cambrian area of Coosa valley and additional study may make it possible to locate them.

The extensive deposits of limonite iron ores which occur in this region are closely connected with these faults. The fracturing of the rocks appears to have afforded an opportunity for the percolation of waters bearing iron in solution so that the iron originally dissiminated through the surrounding rocks has been leached out and redeposited along these fault lines.

The difficulties of determining the structure of this region or even of accurately mapping the surface outcrops of the various formations are greatly increased by the decay and deep disintegration of the rocks brought about by the faulting. Thus the chert of the Knox dolomite, which is elsewhere an unfailing index to that formation, frequently disappears in this intensely faulted region. Chert or flint is simply silica in an amorphous or uncrystalline condition. Where it has been subjected to great pressure, with the increased temperature which must have accompanied so extensive faulting, an internal re-arrangement appears to have taken place in the chert by which its character is wholly changed and it becomes an incoherent white substance closely resembling chalk. This chalk-like material is often found associated with the limonite iron ores, and it sometimes retains the external form of chert nodules. It of course offers little resistence to weathering and affords no indication on the surface of the underlying formation so that the outcrops of all the Silurian formations are frequently deeply covered with a uniform deposit of red clay soil.

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EXPLANATION OF PLATE.

Plate I. Sketch map of a portion of Lookout mountain, W and Sand mountain; showing various stages in the developm present drainage system and topography.

Fig 1. Showing the undulating surface which determined position of the streams. B B and T T flow in synclinal troughs a side streams l, l, l and s, s, s from the intervening anticlinal ridge

Fig. 2. Showing a stage in the development when the side str and s, s, s have cut through the hard surface rocks to soft beds be lateral valleys, w, w', etc., are being formed parallel with the axis.

Fig. 3. Showing a further stage in the development when stream, w, has cut through the intervening divides and diverted age of l' and l''. A second series of lateral streams, W, etc developed along the anticlinal parallel with the first series, W W, upper portion of the synclinal stream, B B, has been diverted stream, R R

Fig. 4. Showing the present drainage system and topograp lateral streams, w and W, have continued to encroach upon the those adjacent, w resulting in the present Little Wills creek and Wills creek. The latter now occupies the axis of the anticlinal t its whole length and has become the dominant stream of the sys consideration. The stream B B has been farther robbed of porti drainage basin by streams flowing eastward to the Coosa. The stream T T has been tapped at various points by streams flowing into the Tennessee and the drainage thus diverted from its origi toward the south.

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GEOLOGICAL SURVEY
OF
ALABAMA.

UGENE ALLEN SMITH, PH. D., STATE GEOLOGIST.

BULLETIN No. 5.

PART I.

A PRELIMINARY REPORT ON THE
UPPER GOLD BELT OF ALABAMA,
i the Counties of Cleburne, Randolph, Clay, Talladega, Elmore, Coosa and Tallapoosa.

BY
WM. M. BREWER, Assistant.

PART II.

upplementary Notes on the Most Important Varieties of the Metamorphic or Crystalline Rocks of Alabama, their Composition, Distribution, Structure, and Microscopic Characters. By EUGENE A. SMITH, GEO. W. HAWES, J. M. CLEMENTS AND A. H. BROOKS.

WITH THREE PLATES.

MONTGOMERY, ALA., 1896:
JAS. P. ARMSTRONG, PRINTER.

To His Excellency,

WILLIAM C. OATES,

Governor of Alabama:

DEAR SIR:—I have the honor to transmit herewith Bulletin No. 5 of the Geological Survey, a Preliminary Report on the Upper Gold Belt of Alabama by W. M. Brewer, with some general notes upon the whole area of our Cyrstalline rocks by myself, and specific notes upon the microscopic characters of the most important of the rocks of this region, by Dr. Clements and Mr. Brooks.

The numerous enquiries which have come to this office, regarding our gold fields will find answer in the first part of this report, while in Part II, I have endeavored to give such a condensed account of the varieties, distribution, and structural features of the component rock masses of this area as has seemed desirable to round out the descriptions of Mr. Brewer.

In the petrographic notes, or descriptions of the microscopic characters of a number of the most important varieties of these rocks, I have presented matter which I am fully aware will posses little interest, if indeed it be even intelligible, to the majority of those who will examine this report; yet from one point of view, it is of equal importance with the economic report which precedes it. Everything which throws light upon the origin and development of the rocky substratum of the portion of earth embraced within the limits of our State boundaries, should be eagerly welcomed by us, for with each addition to our knowlege of the mode of formation or accumulation of our deposits of valuable minerals, we are placed in position the better and more certainly to estimate, in advance of actual development, the possible as well as probable extent of our resources in regard to them.

In the hands of competent students, thin sections of rocks examined under the microscope, have yielded more abundant and at the same time more certain and definite information concerning the origin and history of these rocks together with their mineral contents, than almost all other methods of investigation combined. If we are to keep at all in line with the progress of the world in the study and presentation of our natural resources, it will not do to neglect any of the sources of information which modern methods of scientific investigation place at our disposal.

We are therefore to be accounted fortunate in having the notes of Dr. Clements and Mr. Brooks upon some of our typical rock varieties, and our obligations to these gentlemen, and to the authorities of the United States Geological Survey, with which Mr. Brooks is connected, are not lessened by the circumstance that these notes have been contributed without cost to our State Survey.

Very respectfully,

EUGENE A. SMITH,

University of Alabama, June 15, 1896.

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PART I.

A PRELIMINARY REPORT ON THE

UPPER GOLD BELT OF ALABAMA.

IN THE COUNTIES OF CLEBURNE, RANDOLPH, CLAY, TALLADEGA, ELMORE, COOSA, AND TALLAPOOSA.

By

WILLIAM M. BREWER,

LETTER OF TRANSMITTAL.

To Dr. Eugene A. Smith,
State Geologist:

Dear Sir:—With this I hand you my report on the gold occurrences of the Upper Belt of the Alabama Gold Regions.

The field work which furnishes the material for the greater part of these notes was done during the summers of 1893–4. Since that time, however, I have had occasion to revisit several parts of the field where active work of prospecting or mining was being carried on, and to revise the notes, and bring them up to date. This will explain the lack of compactness or unity in some of the descriptions, especially of the Pinetucky, Idaho and Arbacoochee Districts.

In describing the gold deposits, I have in this report, commonly spoken of them as bedded veins, stratified deposits, etc., and have made use of the terms stratification, strata, and beds, in connection with the rocks of the country. These are the terms most naturally suggested by the general appearances, and they will perhaps be better understood by the majority of those who may make use of this report.

I am aware, however, of the fact that the structure of these crystalline rocks may in many cases have no connection with stratification, since the fully crystalline schists are now generally considered to have been derived by metamorphism from massive igneous rocks, and even in the rocks of sedimentary origin—like the Talladega slates—the planes of cleavage may not necessarily be the planes of original stratification.

With this explanation I trust that my use of the terms

above indicated may not be wholly objectionable, although strict accuracy would perhaps suggest that they be discarded, and the terms "*Stringer-leads*," "*Linked veins*," "*Schistosity*," and "*Schists*," etc., be substituted.

WM. M. BREWER.

Heflin, Ala., April 10th, 1896.

THE UPPER GOLD BELT.

In the report of Dr. Wm. B. Phillips (Bulletin No. 3) on the Lower Gold Belt of Alabama, he refers to a division of the gold fields of the State into "Upper" and "Lower" for convenience of reference.

The dividing line, which is the boundary between the counties of Talladega, Clay and Randolph, on the north, and Coosa, Tallapoosa, and Chambers on the south, I have respected in my examinations.

Beyond the connecting of the formation of the distinct leads of gold bearing ore, and the determining of the continuity along the line of strike of these leads which have their south-western terminations in the Lower Gold Belt, no reference will be found in this report to occurrence of gold bearing ore south of this dividing line, except in some cases not referred to in Dr. Phillips' report, because of his being called from the field by the reason of sickness in his family, before the completion of his survey.

Consequently, while this report is on the Upper Gold Belt as just defined, the first pages are devoted to a furher description of that section of the Lower, omitted by Dr. Phillips in his report above cited.

SILVER HILL BELT.

TOPOGRAPHICAL AND GEOLOGICAL FEATURES.

The name above given was taken from the mine situated in the hill locally known by that name, in Secs. 16 and 17, T. 20, R. 22; and about 1½ miles south of that prominent feature of the landscape, mentioned both by Prof. Tuomey in his report dated 1858, and Dr. Phillips in his, dated 1892, and referred to by them as the "Devil's Back-bone."

The fact that this is the most south-easterly of any belt or series of leads of gold-bearing ore in the State, is one of my reasons for taking it up first in my report.

In both the reports above referred to, no particular mention is made of the extent longitudinally of this bold ridge, or of the location of its south-western extremity which I found to be in Sec. 18, T. 19, R. 21 in Elmore county, about 2 miles north-east of Eclectic P. O. There it is that the 'Talladega' semi-crystalline slate is first seen as one travels north-east from Wetumpka; and there also is the point where the ridge, which extends as a bold feature of the land-scape across this section of the State, and into Georgia, first assumes definite outlines.

The name of "Devil's Back-bone" does not receive local recognition in Elmore county, nor does the ridge assume its full proportions so far as height and barrenness are concerned until it crosses into Tallapoosa county at the extreme north-east corner of Elmore county.

The strata of semi-crystalline slate and quartzite which compose this ridge have their lines of strike north-east and south-west with a south-east dip, and consequently the ridge itself possesses the same trend, maintaining its continuity per-istently in this portion of Elmore county, except where it is cut through by Channahatchee and Kielijah creeks.

MINING OPERATIONS.

Channahatchee Creek and Peru Branch.

While gold has been discovered immediately on the crest of this ridge in Tallapoosa county, yet so far as at present known, such is not the case in Elmore. Limited prospecting work has been done in years past on Channahatchee creek,but such was abandoned, almost beyond the recollection of the oldest settlers;and despite recent excitements on the north-eastern side of the river on this belt of semi-crystalline slate, in which several gold-bearing ore bodies have been discovered, no one has faith enough to prospect this ridge on the south-western side.

This "Devil's Back-bone" ridge crosses the Tallapoosa river in Sec. 32, T. 21, R. 22, and preserving its general characteristics in a north-easterly course, crosses the Columbus and Western Railroad at Jackson's Gap Station; and again crosses the Tallapoosa river near the northern borders of the Horse Shoe Bend in which is located the old battle ground where Gen. Jackson routed the Indians.

The "New Yorker Shoals" also cross the river in the same vicinity in Sec. 24, T. 23, R. 23 E. or to locate the crossing exactly, this range line follows the river which at this point runs north for a short distance. The "Devil's Back-bone," while its course can be readily traced to the north-east, across the Tallapoosa for the third time, near Denny's ferry in the north-western corner of Chambers county, thence across Randolph county and into Georgia, does not form as prominent a land mark as in the vicinity of the gold mining district in Tallapoosa county. The semi-crystalline Talladega slates and quartzites form the ridge and its flanks throughout this entire distance, and many of the occurrences of gold-bearing quartz are associated with these rocks.

Besides the old workings referred to already, on Channahatchee Chreek, I was also informed of other prospecting which had been done in the past in Elmore county in this vicinity on Peru Branch. But it is impossible to get any thoroughly reliable information as to the results of this early work, which was carried on in the most primitive methods of gold mining, and only the ore near the surface which was thoroughly oxidised was treated, together with any placer gravel beds that occurred on the creeks and branches.

Silver Hill, Blue Hill, and Northeastward.

One fact is noticeable throughout this Silver Hill belt; from beyond Blue Hill, which is located in Sec. 33, T. 21, R. 22, in a north-easterly direction, no prospecting has been done anywhere on the bold and prominent quartz outcroppings, which rise above the apex of the ridge proper, in many places, to the height of 10 or 12 feet. These outcroppings are composed of a sugary quartz, many samples from which, I found, panned colors; as also was ascertained by Dr. Phillips.* The reason why no work has been carried on is obvious, for except where this ridge is cross cut by the river and creeks, to obtain the water supply necessary for conducting mining and milling operations would require the investment of large capital to render it available.

For this reason, as well as because the ore is invariably richer, all mining, except in the immediate vicinity of Blue and Silver Hills, has been carried on in the less prominent ridges in the same country rock, which parallel the Back-bone proper.

In traveling to the north-east from Blue Hill I found that the gold-bearing quartz and graphitic slates were not as closely associated as is the case at Blue and Gregory Hills (both in the same land section), where the two become a conglomerated mass so intermixed and irregular in structure that it is impossible to separate the one from the other, and the entire hill sides are quarried down and sent to the mill. This product from the mines was yielding, at the time of my visit, about $2.00 a ton, or rather that amount was saved. I am of opinion though, after panning several average samples, that at least double this amount would be saved, were some process devised for eliminating the graphite before amalgamation was attempted. Apart from this graphite the ore which I saw mined at Blue Hill had no refractory characteristics, but in the other mines in the vicinity the ore is heavily sulphuretted, even at shallow depth. A sample of ore from the Nichols opening, near Blue Hill, gave on analysis $8.66 per ton. This ore has very little graphite. The Devil's Backbone, and indeed the entire belt of semi-crystaline slates are partially or entirely cross cut at irregular intervals by the waters of Big Sandy Creek, at Pace's mill, Sec. 15, T. 21, R. 22 E.; by Manoa Creek, Sec. 34, T. 22, R. 22 E.; by Jackson's Gap cut on the Columbus and Western Railroad, Sec. 13, T. 22, R. 22 E.; by the Tallapoosa River at Horseshoe Bend, already referred to; by Jay Bird Creek between Jackson's Gap and the Horseshoe Bend, Sec. 33, T. 22, R. 23 E.; by Galloway Creek and Hardnett's Mill Creek, two miles south of Daviston P. O. near the northeast corner of Tallapoosa county; by the Tallapoosa River at Denny's Ferry in Chambers county, and by some of the head-waters of High Pine Creek in Randolph county; as well as by the headwaters of Wehadkee Creek in the same county near the State line.

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*Bulletin No. 3, Alabama Geological Survey.

Jackson's Gap, which I have referred to as cross cutting the Backbone, affords a good opportunity for studying the formation and structure of this ridge. In a deep cut made by the railroad, about 25 feet in depth and 100 in length, I noticed that the strata of slate and quartz have been twisted and folded into snake-like contortions, having no regularity in dip or thickness, as depth is attained. The stringers of quartz are interpolated between the slates, without any conformity, and having a lenticular or kidney-like structure. A thick outcrop at the surface in several places pinches out a few feet below; while in other instances although no outcrop occurs at the surface, yet 10 or 20 feet below kidneys of quartz are seen imbedded between the slates in masses and pockets; in one case, attaining a thickness of several feet at the bottom or floor of the cut, and this body of quartz extended below the bottom or floor of the cut.

From the formation in this cut, also from the fact that the Bonner-Terrell and Gunn properties located on a parallel ridge possess the same structure, I am inclined to the opinion that gold mining in this vicinity would prove quite uncertain.

In width, I find that this belt of semi-crystalline slate with the associated gold-bearing ore, is more extensive than is generally supposed. While the main lead apparently outcrops along the crest of the Devil's Backbone, I observed outcrops and old workings, at many points along the line of strike of the belt, more than a mile and a half to the south-east; but the Devil's Backbone apparently marks the line of the northwestern border; beyond which you pass at once into gneiss and mica-schist.

Bonner-Terrell Mine and Vicinity.—In the vicinity of Jackson's Gap there are only two known evidences of gold bearing ore. These are the Bonner-Terrell and Preacher Gunn properties. The first named is located on Sec. 19, T. 12, R. 23. It was worked to some extent, as the old openings demonstrate, some years since, and a stamp mill was run on the ore; but for some reasons the old openings were abandoned and allowed to cave in, the mill was torn down and moved away, and to-day it is impossible to form any idea from an examination as to the extent or value of the ore.

The last named is located on Sec. 30, T. 22, R. 23. Here only shallow prospecting has been attempted. Some samples from a narrow seam of quartz bedded conformably with the country rock panned quite richly, but the formation is apparently similar to that at Jackson's Gap with regard to structure, and the work is entirely insufficient to warrant any opinion regarding the prospect; beyond the statement that some of the quartz carries gold. At another point on this same property a shallow pit exposes a seam of ore about 18 in. or 2 feet in thickness. This however does not pan as richly as the thin streak, while the same facts exist as to work, etc.

Loah Creek Gold Mining District.

This is the local name given to that portion of the Silver Hill belt which lies adjacent to and in the vicinity of the Horseshoe Bend of the Tallapoosa River, and the New Yorker Shoals. The name is taken from that of a creek which empties into the Tallapoosa River on the southeast side near the New Yorker Shoals.

This district on both sides of the river was quite extensively worked several years ago, and a stamp mill, or as it was then called, a "pounding mill," was operated on ore mined from near the surface; but work was abandoned when sulphurets were encountered. Since then the old openings have been allowed to cave in and fill up with debris, so that it was with difficulty I could enter the same, and examine the ore bodies.

These occurrences were not on the Devil's Backbone ridge proper, or *Sheep Hill*, as this portion of the ridge is locally called, but on ridges having their trend nearly parallel with the main ridge, and located about one mile to the southward of it.

Jennings', S. W. Sec. 26, T. 23, R. 23 E.—This property is the southwestern-most in this district on which a body of gold-bearing ore has been discovered and prospected to some extent. There appears a slight change in the character of the country rock; which has the appearance of a hydro-mica schist rather than the semi-crystalline "Talladega" slate. The ore is a somewhat sugary decomposed quartz, and the body I examined was a seam some 6 to 8 inches in thickness in apparent conformity with the country rock. The openings in this property were all shallow prospect pits, and beyond the fact that it panned at about the rate of $3.00 or $4.00 a ton, but little could be determined as to structure or permanency.

Tapley, S. E. Sec. 26, T. 23, R. 23, E.—This property adjoins the Jennings, and is apparently an extension of that ore body. The openings were more numerous and extensive. In fact in one place ore had been mined a depth of 50 feet, but so long ago that the timbering had rotted and the openings were inaccessible. Some of the ore remained on the old dumps. This was a whitish flinty quartz, highly sulphuretted, and quite undesirable for treatment by amalgamation. Several tons of ore from this property had been treated in the mill already referred to, but no reliable information could be obtained as to the results.

Where I was able to see this ore body I found it showed about the same thickness as on the Jennings property, with its line of strike N. E. and S. W. and dipping at an angle of about 45 deg. slightly E. of S. There are also several thin stringers of a bluish colored, hard sulphuretted quartz on these properties; all of which show gold by panning, so far as I was able to test them.

Hammock, S. W. Sec. 24, T. 23, R. 23, E.—This property was mined on about 12 years since, and the mill above referred to was then in operation on a branch which flows through the property. Nothing now remains to mark the spot where the mill stood except some rotten timbers, and an old ore dump. It is claimed that some of the ore from this property milled $30.00 a ton in free gold, but a sample I took from the dump, assayed only $5.70 a ton in gold. The ore resembles the Tapley; being a highly sulphuretted hard quartz. The sample I took was, as near as I could judge, without systematic sampling, a fair average of a few tons which still remained on the dump. Milling and mining were suspended, it is claimed, because the ore was too highly sulphuretted to work profitably by ordinary amalgamation. No information whatever could be gathered from the old openings.

Greer, S. E. Sec. 24, T. 23, R. 23. E.—From the Hammock property I traced the same lead of quartz by the outcrop, to the Greer, which extends to the Mule-shoe Bend of the Tallapoosa River, situated partially in the eastern portion of this same section. The ore here has the same general characteristics as in all the openings, as well as in the outcroppings, through this district, and apparently is of about the same relative value. From the best information I could obtain, ore from all these properties in this district on this side of the river was milled in the Hammock mill some 12 years since; but no work has been done recently, except that some of the shallow pits were partially cleaned out to enable me to see the ore body, which has the structure of a bedded vein, in the hydro-mica schist country rock, conformably with the general formation and having its line of strike N. E. and

S. W., and dipping at an angle of about 45 deg. towards S. E.

Crossing the river at the Griffin ferry in Sec. 24, T. 23, R. 23 E., I continued my work of tracing this gold lead or belt by actually following along the line of strike of the formation towards the Georgia-Alabama State line. In this I found some difficulty, because except in the vicinity of the river, the outcrop had lost some of the bold and prominent features it possessed towards the S. W. As nearly as I could trace it by the country rock, which along the south-eastern border of the belt still maintained those characteristics which led me to classify it as a hydro-mica schist, but towards the north-western border preserved the appearance typical of the "Talladega" semi-crystalline slate, I found that the belt continued along the summit and sides of a well defined ridge. Though not as prominent a land-mark as the Devil's Back-bone to the south-west, yet it was sufficiently persistent to be considered an extension of that ridge.

Johnson, W. half of S. W. Sec. 17, T. 23, R. 24. There are several old workings in this vicinity, consisting of tunnels and shallow incline shafts which were made in 1840 to 1845; when, judging from the old dumps and the extent of the workings, quite extensive mining operations were carried on.

This Johnson property is located in the forks of the river and Sweet Water creek on the north, or rather north-west, side of the river. The outcrop of quartz, much of which prospects, is quite bold and prominent, continuing along the line of strike N. E. and S. W. with hardly a break, to the river, a distance of about a mile and a half.

The character of this quartz is sandy, sugary, very much stained with iron oxide, partially decomposed and porous.

A sample selected at haphazard, analyzed by Dr. J. H. Pratt of Birmingham, Ala., yielded $3.43 a ton in gold. In panning several samples I noticed that the results averaged very evenly, more so than almost any other quartz outcrop I have tested in this State. These were all taken at haphazard from the outcrop, and were not sampled systematically by quartering as should be done; but I lacked both time and facilities for doing such work.

As is the case on the opposite side of the river, some work was done here ten or twelve years since, and ore milled. At the present time, though the openings are in such a condition that it is impossible to estimate the character or extent of the ore body, except from the outcrop, which, while it has a general line of strike and dip, has but little regularity in structure.

The gold contained in this ore is very fine, but appears to be free-milling at and near the surface, though undoubtedly sulphurets will be present at depth. To the south-west on the

Griffin property, Sec. 19, T. 23, R. 24 E., the same lead of quartz, apparently, can be traced across that tract from which it enters the river. No work of any description had been performed here at the time of my visit, nor indeed could I learn of any other mining work, having been carried on along the line of strike of this Silver Hill belt to the north-east in this State.

My attention was attracted to the different appearance and nature of the quartz occurring in the several leads on the two sides of the river, in the Devil's Back-bone proper, as well as in the parallel ridges, a mile or more to the south-east, where most of the mining has been done. While the gold-bearing ore on the northern side of the Tallapoosa, so far as I observed (and I saw, and tested samples by panning, from all the known bodies which outcrop, or have been mined), is of a sugary, sandy character, somewhat decomposed and porous, and plentifully stained with iron oxide; that on the southern side, especially in the southeastern-most bodies, is of a hard, glossy and flinty nature, carrying a large per centage of sulphurets, and some magnetic iron.

North-East of Eagle Creek District.

To the north-east along the line of strike of the country rock, I traced this belt across Galloway creek about 2 miles south of Daviston, where I found apparently the same ledge of slate as at the New Yorker Shoals with quartz interpolated between the strata. Thence to Hardnett's Mill creek, two and a half miles further to the north-east, where the same ledge crosses the creek a short distance north of the mill. Thence to the Mountain Spring church on the Chambers county line, Sec. 19, T. 24 N., R. 25 E.

A short distance from this church, to the north-east, in the same section, and along the crest of a high ridge, from which the church derives its name, the outcrop of quartz again assumes the bold outlines it possessed along the Devil's Backbone in the vicinity of Blue Hill, and rises several feet above the surface in immense slabs and boulders. Some of this quartz is in place, but no enclosing walls of country rock are exposed, except in such a rotten state as to render its classification quite difficult. Near by, though where less decomposition and erosion have taken place, the country rock, are the same semi-crystalline slate and hydro-mica schist, which characterize the entire belt. The dip of this quartz in places is almost vertical, and the strike conforms with the general line N. 40° E. This quartz is of the same sandy, friable character as in the outcrop along the Devil's Back-bone proper, but samples I took failed to show any colors of gold in the pan, although the presence of black sand with some sulphurets indicated that there might be gold bearing chutes or chimneys in the body. I followed this outcrop along the ridge and towards the Tallapoosa river, which it crosses at the mouth of Laney creek, about one mile below Denny's Ferry, and five miles due east from Daviston. I could find no openings on this outcrop along the ridge, or in this semi-crystalline formation in this vicinity, to indicate that any prospecting had been done, nor could I learn of any work which resulted profitably having been performed on this Silver Hill belt north-east of the river at any point between it and the Alabama-Georgia Line.

The belt of semi-crystalline slate and hydro-mica schist maintains its continuity, with many seams of quartz interstratified, as I demonstrated by crossing the formation at various points along its line of strike. The course is north-easterly from Denny's Ferry across the north-western corner of Chambers county; thence into Randolph south-east of Louina, crossing the county, passing near Handley P. O., thence to the State line.

Near Rock Mills, Randolph County, about five miles in a direction slightly north of east from Roanoke, and in Sec. 27, T. 21, R. 13 E., it is reported that while the Indians resided in that vicinity, as well as more recently, placer gold has been found in the bed of Wehadkee creek, but no signs of any extensive work can be found.

So far as I could ascertain the occurrence of gold in this section is based entirely on legend and tradition; many stories of the Indians bringing gold dust to the traders in small quantities are related by early settlers, but no one appears to place sufficient faith in such accounts to feel warranted in expending money for prospecting during recent years.

So far as I could discover from my own tests, as well as the best information I could obtain on the subject, I feel warranted in stating that no gold in paying quantities occurs in Alabama south-east of the Silver Hill belt; although the crystalline schists, hornblende and gneiss formations continue in a south-easterly direction some 40 miles, or to the latitude of Columbus, Ga.

OCCURRENCES OF MICA, CORUNDUM, SOAPSTONE AND ASBESTOS.

Immediately south-east of the Silver Hill belt, and paralleling the same, we find first strata of graphitic slate, which I noticed at one point on the Germany Ferry road between Daviston and Dadeville on the north-west side of the Tallapoosa river, to be at least 40 feet in width where the public road cross cuts the slates. Next in the series of mineral belts paralleling the Silver Hill, are veins of coarse grained granite, from which mica in crystals sufficiently large to possess a commercial value, has been mined. I found the best points to study these parallel belts was in the vicinity of Dadeville and Buttston, also near Easton P. O. about 7 miles northerly from Dadeville.

From my observations in this neighborhood, I found that the mica belt just referred to, was followed by a belt of soapstone.* Associated with which were corundum and asbestos. In its turn the soapstone was followed by another belt or series of veins of coarse grained gneiss, and mica schist which indicated the occurrence of mica of commercial value.

This last occurrence of mica together with the soapstone and other minerals are what is locally known as the mica, corundum and asbestos belts; which parallel the strata of graphitic slate, in their turn paralleling the Silver Hill gold belt on the south-east border.

I have observed in Carroll county, Ga., apparently the same series of mineral bearing formations; which cross that county in a north-easterly course. Although the outcrops are not continuous above the surface, yet I am of opinion from the general character of the formations that these belts are south-western extensions of those in Georgia. Especially, as I am reliably informed since the same occur in Heard county, Ga.

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*The soapstone, and other minerals here mentioned, are associated with masses of basic igneous rocks (pyronene and chrysolite) and some of them—soapstone chlorite and are the products of the alteration of these by weathering. E. A. S.

So far as I could ascertain the only work of any extent that had been performed in search for

Mica in this neighborhood, or indeed anywhere on this belt, was on the Holly plantation about 2 miles east of Easton P. O. Here a pit some 15 feet deep had been recently sunk and merchantable mica mined and shipped to St. Louis. But at the time of my visit (Nov., 1893,) the work was suspended, and from the manner in which it had been done, it was impossible for me to form any idea of the permanency of the deposit.

Immediately north of this belt bearing mica, extends what is locally known as the

Corundum and Soapstone belts where about 12 years since Dr. Lucas, a resident of North Carolina, who had purchased a tract of land on the Tallapoosa river, including a portion of the New Yorker shoals, with the avowed intention of utilizing the water power for manufacturing purposes, gave the industry of corundum mining quite an impetus by purchasing the product of this belt. He paid from $50.00 to $60.00 a ton, but was driven from the market by another dealer, who for a time paid a higher price, but ultimately failed. Since then the industry has been entirely abandoned in this section of the State. I visited some old openings that were made at that time on the Hanby plantation, adjoining the property, on which is located Easton P. O. on the east; also at the Bartlett plantation 2 miles north of Dudleyville, and the Holly plantation 2 miles north of Hanby's.

At the last named, soapstone only had been found, and mined to a limited extent; some of the blocks which had been sawed out at the time active mining operations were being carried on, still remain on the ground.

Whether sufficient corundum can be found in the beds on this belt, to be of commercial importance in the future, is impossible to estimate. The old openings are partially filled up with debris, and apparently were sunk until a hard variety of soapstone was encountered and then abandoned.

I find this corundum and soapstone belt extends as far to the south-west as the vicinity of Dadeville, and to the north-east in the neighborhood of Milltown, but as to the exact extent longitudinally, I have not determined.* In width it is of inconsiderable extent so far as at present known; not exceeding 2 miles, so far as I can learn, at any point.

There apparently occur two series of beds with parallel lines of strike; both of which cross the Hanby plantation, before referred to; but I can find no trace of the occurrence of any corundum or soapstone north of the Bartlett plantation and south of the Silver Hill gold belt. This last named property is in a line north-east from the Hanby, and distant about 5 miles.

On the Germany Ferry road to Dadeville the most northern indications of corundum and soapstone occur at the crossing of Soapstone Creek 2 miles south of the ferry. At this point immense outcroppings and a ledge of chrysolite rock show in the wagon road, which apparently has close connection with the soapstone corundum beds; for the same rock is again found on the Griffin Ferry and Dadeville road near an old church, in the northern portion of T. 22, R. 24 E., as well as at other places along the line of strike.

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*Another somewhat similar belt is on the N. W. side of the Devil's Backbone ridge, showing near Foshee's Mill (Fosheeton) and far to the southwestward at Robert Goodman's, south of Alexander City. At Goodman's a considerable quantity of corundum has been observed. E. A. S.

I also found some samples of

Asbestos closely associated with the corundum and soapstone, at the Bartlett plantation, but of a very poor quality; as good, however, as that found in Carroll county, Ga., which at a depth of 12 feet was not of sufficiently good grade to command any commercial value.

Whether the grade will improve as depth is attained in the workings I am unable to state; but so far as I could learn from personal observation or information, no work has been done on the Alabama side to determine this.

One and a half miles north of the Bartlett plantation the Tallapoosa River flows, and between these points some mica has been found, along that northerly belt I have referred to already, as paralleling the graphitic slate, but of inconsiderable quantity, so far as at present developed.

The country rock associated with the corundum and asbestos is a talcoid-schist; with boulders of soapstone, and a green colored rock probably chrysolite, there are also specimens of actinolite and tourmaline plentifully found with the float and surface rocks. A ledge of dark green hornblendic rock is also a noticeable feature in the geological formation, which I have failed to find elsewhere in this crystalline region, except along the line of strike of these particular belts. The largest outcrop of this is near Dudleyville, where the wagon road cross cuts it angling. * This is on the road between Dudleyville and Buttston.

The mica-schist and gneiss formations are continuous paralleling the Silver Hill belt on the S. E. to the Alabama-Georgia boundary line, crossing Randolph county through Roanoke, thence by Rock Mills to the line, into Heard County, Ga.

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* See foot note to page 18. E. A. S.

GOLDVILLE AND HOG MOUNTAIN BELT.

In my report I have retained the same name for the upper portion of this belt, which occurs to the north-west of and paralleling the Silver Hill, as that used by Dr. Phillips in his report on the Lower Gold Belt. My examination of this began in Clay county; because in the report of Dr. Phillips above mentioned, the south-western portion of this belt has been fully, and very ably described.

TOPOGRAPHICAL AND GEOLOGICAL FEATURES.

Before taking up the description of the gold leads on this belt, I will occupy a little space in briefly describing the geological formation of the fully crystalline region which intervenes between the Silver Hill belt of semi-crystalline slate and hydro-mica schist, and this Goldville belt, which is formed by the Talladega and other semi-crystalline slates; with boundaries of gniess and flat rocks, usually called granite, both along the south-east and north-west borders.

The average distance intervening between these belts is about 6 miles, which can be definitely traced on the map, by drawing a line with a N. E. S. W course intersecting Daviston on the north-western boundary of the Silver Hill belt and New Site on the south-eastern boundary of the Goldville belt. In Randolph county the semi-crystalline slates are greater in width than in Clay or Tallapoosa counties, and have intruded on the fully crystalline, or vice-versa; for it is not yet decided which formation is the older. This intrusion* is

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*See Part II of this Report, where reasons are given for thinking that the structure of these crystalline rocks is not *stratification*, but a secondary character (*schistosity*) produced by dynamic metamorphism of originally massive igneous rocks. E. A. S.

really interstratification; because the series of the formation follow each other conformably. But alteration appears to have taken place along the line of the strike; so that in traveling across the formation from Louina to Almond P. O. a series of strata of semi-crystalline slate occur, which are not seen south of the Clay county line. While in traveling from Roanoke to Wedowee these fully crystalline schists and gneiss appear to be narrowing down, and about 1 mile east of Wedowee disappear entirely, with the exception of about 100 acres of gneiss and flat rock occurring about 2 miles north.east of Wedowee, portions of Sec. 23 and 24, T. 19, R. 11 E. Immediately paralleling the Silver Hill belt on the northwest in the vicinity of the Eagle Creek Mining District I found massive boulders and beds of gneiss, which maintain their continuity longitudinally to the Alabama-Georgia State line. On the line of strike towards the north-east this bedded gneiss assumes the structure of

Flat Rocks in many places on both borders. and is usually designated as granite, and often as dikes. But although these flat rocks in some places cover several acres, as at Almond P. O., (at that place the flat rocks cover nearly or quite 200 acres, being 2 miles in length N. E. and S. W. and ¾ mile wide,) I find the lines of stratigraphy* quite well defined, showing conformity in the bedding with the semi-crystalline slates on both S. E. and N. W. The same state of facts I find on close observation prevails wherever these flat rocks occur, consequently instead of treating them, and writing of them as granites, I shall refer to them always as gneiss. As these occurrences are possessed of a commercial value, I have taken pains to locate the most prominent in this portion of the State as follows:

Almond, S. E. of Sec. 29, S. W. Sec. 28, T. 21, R. 10 E.

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*See preceding foot-note. E. A. S.

Almond, Sec. 5, T. 22 S, R. 10 E.
Motley Mill, Sec. 4, T. 24 N. R. 24 E.
Handley, Sec. 22, T. 20 S., R. 12 E.
Forester's Chapel, Sec. 29, T. 21, R. 11 E.
Portions of Secs. 28 and 27, T. 21, R. 10 E.
Rock Mills, Sec. 27, T. 21, R. 13 E.

The foregoing all occur on the north-western border of the Silver Hill belt, except the exposures at Rock Mills, which is in the crystalline region south-east of this belt.

The exposures along the line of strike of the gneiss forming the north-western boundary of the Goldville belt, are as follows:

Knight's Mill, Sec. 35, T. 20, R. 9 E.
Carwile, S. E ¼. Sec. 34, T. 20, R. 9 E.
Wm. Orr, N. W ¼. Sec. 35, T. 20, R. 9 E.
Dawkins, Sec. 8, T. 21, R. 9 E.
Grizzle, N. W ¼. Sec. 24, T. 20, R. 9 E.
Blake, N ½ S. E ¼. Sec. 18, T. 20, R. 10 E.
Blake, S½, N. E ¼. Sec. 18, T. 20, R. 10 E.
Devon, S. W ¼. Sec. 18, T. 20, R. 10 E.
Moore and Duke, portions of Sec. 23 and 24, T. 19, R. 11.

The only place where any quarrying is at present being carried on is on the last named exposure, which is two and three-fourths miles north of Wedowee. Here a firm of bridge builders, the Alabama Bridge Company, are quarrying the rock for piers and abutments for a new bridge across the Little Tallapoosa river on the wagon road to Heflin. About 500 tons will be quarried for this purpose, and the rock is pronounced as of a very superior quality. An ample supply, I was informed by the contractors, will be obtained without the necessity of quarrying to any considerable depth; in fact, at present, only the rocks which have become split by weathering have been used.

I can not learn of this rock having been quarried and used for building purposes within the boundaries of the Upper Gold Belt, but such has been done at Rockford and Goodwater in Coosa county with very satisfactory results. The rock from that vicinity has the same characteristics as that found in Randolph county, where such rock has hitherto only been utilized for gravestones, mill stones and chimneys.

These belts of gneiss are followed on the south-eastern border of the Goldville belt by the semi-crystalline Talladega slate. The general dip of this entire Upper Gold belt section of the crystalline region inclines towards the east and south-east. The structure is, I notice, generally conformable at the lines of demarcation between the gneiss, and either the slates or schists; and I failed to observe at any point any special change in the dip, or any appearance of greater deformation than is usually seen in this section of the Appalachian system. The dip generally throughout the Goldville belt is more nearly vertical than in some other sections, but the changes in the dip at these lines of demarcation I have referred to, do not appear extraordinary, as would be the case if the gneiss strata were granite dikes, though such conditions even might be produced by shearing, which from Dr. Becker's report published recently is that authority's opinion. A study of the formations bordering this Goldville belt in the south-western direction demonstrates that these gneiss belts are continuous, and persistently maintain their places in the series in the Lower Gold belt. So that by actually following along the line of strike on either border of this gold belt I am of opinion that the gneiss will maintain its continuity longitudinally equally as persistently as do the mica schists, hornblendes or slates.

DETAILS OF GOLD OCCURRENCES.

I really took up my work of examination of the Upper

Gold belt near Almond P. O., in the south-western corner of Randolph county, where I made every effort in my power to connect, or discover a north-eastern extension, of the gold bearing lead, which is described by Dr. Phillips as maintaining its line of strike so persistently from Hillabee creek to the northern line of Tallapoosa county. But I could find no occurrence of gold-bearing ore, so far as at present known, on this belt, south-east of Malone's ferry, Sec. 11, T. 21, R. 10 E. On the

Browning property, Sec. 8, T. 21, R. 10 E., about two miles north-west of the ferry, I found the first occurence that had been prospected. This is the southernmost ore body in this formation on which any prospecting had been done on the Upper Gold belt. The shallow prospect pits exposed a low grade of gold-bearing ore, but the work, at present, is insufficient to determine the value of the occurrence, or any facts relative to permanency, or extent of the ore body.

From this point I proceeded to the old Bradford settlement, now known as the

Goldberg Mining District,

on Crooked creek, on the west side of the Tallapoosa river. This has heretofore generally been considered to be a north-eastern extension of the gold-bearing lead from Hilabee creek to Goldville in the Lower Gold belt. In being located in the same strip of semi-crystalline Talladega slate, it may be considered so still. But while lying in the same country rock, I found that the Goldville * lead proper occupies a position on the south-eastern edge of the gold-bearing formation, while the Goldberg lead occupies a position near the north-western edge of the same formation. If there should ever be established any connection along the line of strike of the ore bodies in this belt, I am of opinion that the Goldberg will be found to be continuous with Hog Mountain lead, which also occupies the same relative geographical position in the belt. But from examination I doubt if any of these leads of gold-bearing ore continue unbroken along the line of strike for any great distance.

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* In designating these series of occurances of gold bearing ore as leads, I do not use the term with exactly the same meaning as is given to such generally in the western mining districts, but rather with the meaning as defined by Webster "a guide."—W. M. B.

I should, from the indications, think that the Browning prospect might be considered an extension of the Goldville proper. To substantiate my conclusions in this respect I find that about 4 miles north of Flat Rock (Almond P. O.) several strong seams of quartz have been cut in working the wagon road known as the Wesobulga and Flat Rock road, but such are barren at this point. These veins or seams apparently persist through a prominent ridge, which is situated geographically to the north-east of the Birdsong pits near Goldville P. O., and in the same semi-crystalline slate formation, having the line of strike corresponding with that of the strata in the Lower Gold belt. The discoveries in the Goldberg district are four miles north of the general line of strike of the Goldville lead proper.

The point where the south-westernmost discovery of gold-bearing ore, on this belt in the Upper Gold region, was made is on the

Dawkin's property, S. E. ¼ Sec. 2, T. 21, R. 9 E. The work comprises some openings made prior to 1860, from which I obtained some ore; a slightly decomposed quartz. By panning I failed to get colors; although the showing of sulphurets was good, and there was some indication that a fire assay would probably show a satisfactory yield in gold.

Within the recollection of some of the oldest settlers a "pounding mill," as it was designated, was operated near the location of these old openings; and the ore mined from them, was there treated by amalgamation.

My attention was next directed to some recently dug openings or shallow prospect holes, on the crest of a ridge, on this same property. The surface of this ridge is plentifully covered with quartz float, and ledges of quartz outcroppings, several in number, with their lines of strike parallel, and having a trend nearly north. These holes I found to be too shallow to enable me to determine the structure of the occurrences; whether they should be classed as bedded veins or as belonging to a stratified deposit.

The ore when panned yielded fair prospects in free gold. It is so far as exposed, of the character and appearance of a feldspathic quartzite, somewhat decomposed, and stained with oxide of iron. The feldspar was decomposed, and kaolin appeared as the secondary product.

The outcrops of some of these strata can be traced to, or rather appear again above the surface on the crest of another ridge, about 400 feet distant in a southerly direction. Judging from the strike these may prove to be extensions of those exposed in the old openings on this property. But such can not be determined because no work has been done to establish or demonstrate such continuity to be a fact, and the outcrops can not be traced above the surface except on the crests of the hills. The location of this plantation is near the forks, and comprises the land enclosed by White Oak and Wesobulga creeks, near, and for some half a mile above, their confluence in Clay county.

Knight's Mill, S. ½ S. E. ¼ Sec. 35, T. 20, R. 9 E.—At this point is a clearly defined line of demarcation in the formation, between the Talladega slate and bed of gneiss, having somewhat of a porphyritic character. This gneiss extends to the southward half a mile or so, but its structure conforms, both on the north-western and south-eastern edges, with that of the semi-crystalline slate country rock.

Narrow quartz veins are found imbedded in the gneiss, some of which prospect colors by panning. But such are too thin, to ever offer any inducement for prospecting, being only from a half inch to four inches thick at the outcrop.

W. D. Mitchell's property, S. 1, T. 21, R. 9 E.—Following White Oak creek down to its confluence with Wesobulga creek on to this property, I found an occurrence of gold-bearing ore a short distance below the junction of the two creeks; in a field adjoining the Heflin and Louina dirt road on the south. Shallow prospect holes had been sunk on a ridge where a vein or seam of hard quartz, stained with iron oxides, had been exposed bedded between the strata of slate. The strike of this was slightly east of north, with its dip towards the S. E. at an angle of 35 deg. The ore panned satisfactory results in free gold; but pan tests on all the ore sin this belt, I found, after testing, to fail to give as good results as could be obtained by roasting and pan amalgamation.

I am unable to give the exact yield of any of the ores, except of a few samples assayed by Dr. J. H. Pratt for the survey; because in the field I lacked facilities for assaying the same. In making tests I am under obligations to Mr. George Camp, a veteran prospector from the West, for valuable assistance, while in this district. By the aid of a blacksmith forge, a frying pan, mercury and porcelain bowl we amalgamated samples with an exactness hardly fo be expected with such crude appliances. As we had no balances we could not determine the values of the ores except approximately, and as such estimates are liable to prove faulty, I have refrained from quoting figures. However in cases when I state that a test proved satisfactory, I am satisfied that $5.00 a ton is a conservative estimate.

It was on this same property, and in close proximity to the last occurrence mentioned, that I saw work done on another quartz seam. This exposed such a rich kidney or pocket, as is rarely encountered. The seam of quartz outcropped on the same ridge, as the first I have mentioned, on this Mitchell property, but distant about 100 yards in a south-easterly direction. The dirt road before mentioned cross cut the quartz seam, and on the northern side of the road the cut was about 8 feet deep.

I had previously been told of a very rich pocket of ore having been discovered on this same body several years before. The discovery though had not been followed by any systematic work; and the hole that was sunk at that time it was claimed had been filled in by the road workers.

The story appeared to me to possess many of the earmarks of an Arabian Nights romance; but Bob Bradford a local prospector insisted that he believed he could, by following the dip of the vein, which is about 35 degrees towards the south-east, discover another pocket. My curiosity prompted me to witness his work.

After sinking about 4 feet below the surface of the wagon road, he was as good as his word, and took from a pocket or kidney in the quartz vein about 75 pounds of ore. This had all the characteristics of arseno-pyrite or mispickel, and when roasted showed that such was the nature of it. During the roast the arsenic and sulphur were sufficiently eliminated to set free the gold, when by stiff pan amalgamation 1¼ pounds of the ore yielded a button of gold of the value of 17 cents, or nearly $300 a ton. Future work at the same place failed to show any more such pockets, but such work only attained an increased depth of about 6 feet. The thickness of the quartz vein at the depth attained was 12 inches. It is apparently interleaved between the slates. The float as well as some outcroppings would indicate that it may persist along the strike of the formation parallel with the seam of quartz I first examined on this same property, and have already referred to. The dip of both these quartz seams is in the direction of the gneiss rock I found interstratified with the slates, and which shows in a mass above the surface, 30 feet to the south-east of the prospect hole in which the pocket was discovered.

On the north-eastern extension of this ridge and about 200 feet from the road another prospect hole had been sunk which exposed still another vein of gold-bearing quartz, with its strike parallel to the two first mentioned, and dipping conformably with the formation, and also with the dips of the other quartz bodies. The structure of these ore bodies as well as their permanency and extent, can only be determined after more work has been done.

My own opinion is that they will continue down conformably with the stratigraphy or cleavage of the country rock, and be subject to the same folding and faulting as that has sustained.

The gravel in Wesobulga creek prospects well in placer gold, at the crossing of the Heflin and Louina dirt road.

Farrar property N. W. ¼ of S. W. ¼ Sec. 36, T. 20, R. 9 E. On this property my attention was directed to some old workings, consisting of a tunnel 50 feet long, and a deep shaft; where mining operations had been carried on before the war of '61 to '65. In the tunnel, which I explored, I found some gold-bearing quartz which prospected by panning. But I was unable to determine the extent or character of the ore body in place, because of the dangerous condition of the opening.

This was really a cross cut, having been run at right angles to the strike of the formations; from the size and appearance of the dumps, as well as condition and extent of the openings, these workings must have been quite extensive for their date. However, I could find no outcrop exposing rock in place in the vicinity of any of these old workings, although pieces of quartz float of a sugary character, stained with iron oxide, and considerably decomposed were very plentiful on the surface; covering several acres.

The only recent work performed on this property which exposed the occurrence of gold-bearing quartz, was the sinking of a well in which a ledge of quartz 15 inches thick was cut near the surface. The strike of this is slightly north of east and south of west, with its dip towards the south at an angle of 25 degrees.

The slate country rock underlying this seam of quartz was mineralised, and prospected by panning as also did the quartz from the vein.

One of the legends of the neighborhood is to the effect, that in the ante-bellum days, old Mrs. Farrar used to pan in the branches which flow through this property. From the gold she obtained, the story goes, she was able to furnish herself with all the pocket money she needed, besides supplying the table with coffee, sugar and other luxuries.

W. D. Mitchell S. W. ¼ of N. W. ¼ Sec. 36, T. 20, R. 9 E. This property adjoins the Farrar tract on the north. Gold-bearing ore, very highly sulphuretted, and having the characteristics of arseno-pyrite, occurs, and a shallow prospect hole had been sunk, but the work was insufficient to enable one to determine any facts as to extent, permanency, or value of the prospect. The ore yielded satisfactory results when roasted and treated by pan amalgamation.

No outcrop was exposed on the surface, so that no idea could be formed of the occurrence, beyond the showing in the shallow pit. This class of ore I usually found nearer to water level, but in this instance it occurred on the crest of a high ridge, and close to the surface.

Dr. Manning's Property, Portions of Secs. 25 and 36, T. 20, R. 9 E.—A portion of this property forms one of the old land marks, with regard to placer diggings. These must have been worked not less than 60 years ago, for the tailing dumps are buried under two feet of soil today, and trees 10 to 12 inches through have grown thereon. From all appearances placer mining must have been carried on quite extensively here in days gone by. But the deposits were not entirely worked out, because at the present time good prospects are obtained in coarse gold, from nearly any of the gravel bars in the creek beds. However these bars are not extensive, and would hardly pay to work. Most of these old diggings were on branches which empty into Crooked Creek on this property, and the section adjoining it on the south.

Gold-bearing ore bodies also occur in the quartz. From the appearance of these ore bodies at several openings on the crest and near the base of a steep ridge, I am inclined to class such as stratified deposits rather than veins, because the strata of gold-bearing rock, and decomposed mineralised slate lie conformably with the general formation, are in fact a portion of that formation, having no well defined walls.

The general line of strike is about N. 40 deg. E. but at some of the openings the folding has been so violent and extreme, that the formation has no general lines of strike and dip; but both are abnormally twisted and contorted, and point in nearly every direction. This state of facts though is only local. At one opening in particular the crest of an anticlinal curve is clearly defined. Several thin veins of quartz, very much stained with iron, but quite hard, cut the formation at right angles. These pan very richly, but are so thin, no work has been done with a view of developing them.

The richest pan tests so far obtained in this district in free gold, I got from average samples on this property. Assays made by Dr. Pratt yielded from samples taken on Sec. 36, $23.03 a ton and $10.42 a ton. These were selected at haphazard, and not from systematic sampling.

The ore in the stratified deposits from the lower strata has arseno-pyrite characteristics, carrying on excess of sulphur and arsenic; but near the surface it has become oxidised, and is of a free milling nature.

Cockrell, N. E.¼ of S. E.¼ Sec. 25, T. 20, R. 9 E.—This property joins the Manning on three sides, the north, west and south; and the waters of Crooked Creek flow through the north-east corner. Here the creek has been dammed, the water-power being utilized to run a grist mill and gin.

A short distance to the north-west of the mill, occurs the outcrop of a gold-bearing quartz seam, between slate walls, with its dip south-east on an angle of 25 deg. The hanging wall (where exposed in a shallow pit) is more vertical than the foot wall, and if such a conditition is continuous for any considerable distance in depth, the permanency of the ore body is certainly endangered. The openings were all quite shallow, indeed so much so, that nothing beyond the occurrence of the ore between the slates could be determined. The character of the ore is the same as I have before referred to as a feldspathic quartzite. Usually on this belt where ore of this character occurs near the surface, it is replaced as depth is attained by a more or less decomposed quartz and sulphuretted ore, from which in some cases rich results are obtained, This feldspathic quartzite, which appears closely allied to mica-less *granite*, in general appearance, rarely gives more than colors, and often only sulphurets. From this last described property I crossed Crooked Creek, which here forms the boundary line between Clay and Randolph counties; leaving the first named and entering the precincts of the last.

Goldberg Mining Company, S. W.¼, Sec. 30, T. 20 R. 10 E.—From the Manning property in Sec. 36 I had followed by observation the lead of gold-bearing ore, and discovered that in a north-easterly direction, as you ascended the slope of a ridge the float and outcrop denoted another body or an extension of the first. This ridge is continuous, except where the waters of Crooked Creek have cut a channel through it, for some considerable distance, and is locally known as the "Bradford Ridge." On this, and another parallel ridge, the company from which this district derived its name, performed prospect work in 1893.

The work done was of a more extensive nature, and more systematic than on most of the properties I had examined on this Upper Gold belt to the south-west. From it I was enabled to form a more comprehensive idea of the structure, extent, and nature of the ore body. At one point an open cut showed a thickness of pay ore 16 feet. At another a shaft sunk on an incline conformably to the dip of the formation, and with the dip at an angle of about 20 deg. towards the south-east, was in ore for a distance of 50 feet from the mouth. This showed a thickness of 6 feet of ore at the face, with ore still below the floor.

These openings were made on the Bradford ridge, a short distance north-east of Crooked Creek.

The first of these (the open cut) showed all the characteristics of a stratified deposit, composed of quartzite, slate and clay interleaved, and capped by a hard quartz. No walls enclosing this ore body could be discovered; the entire thickness prospected, and some of the strata yielded quite rich results. The dip of this deposit conformed with that of the formation in the shaft. But at the heading in this shaft the dip increased to an angle of about 45 deg.; there water interfered with further progress. The ore body at this point was more solid, and the distinction between pay ore, and country rock better defined.

From the increased angle of the dip together with this change in the ore body, I was led to believe that as depth was attained the structure might change and assume the characteristics of a segregated or bedded vein.

This theory I found sustained by the conditions at the Franklin mine in Cherokee county, Ga., which I visited in 1893; the country rock was a mica-schist though, instead of slate. The solid formation at that mine was encountered at a depth of 115 feet. Sinking was continued on an incline shaft until it reached a depth of 425 feet, on an incline of 45 degs. From the point where the solid formation displaced the decomposed material, well defined slate walls enclosed an ore body of about 16 feet in thickness, bedded in conformity with the dip of the slate, and apparently continuing down, an undetermined depth.

Above this solid formation, I was reliably informed that the body was composed of such strata of quartzite and mineralized schist with clay as occurs on the Goldberg property, the only difference being the nature of the country rock and the angle of the dip. Besides the two openings I havementioned on the Goldberg property on the Bradford ridge, I found several others of greater or less extent,along the line of strike of the ore body. In all of these the same character of ore had been exposed, which tended to show that the body was continuous along the strike, a considerable distance. The ore, as depth was attained in the incline shaft, carried a greater percentage of sulphurets, and after roasting, prospected much richer than at the surface. While the average yield will not exceed $5.00 per ton, yet some picked samples have assayed as high as $100.00.

The following assays from this property were made for the survey by Dr. Pratt, of Birmingham, Ala., from samples taken at haphazard: $5.15, $3.14, $2.56 a ton respectively.

On a ridge parallel to and a short distance to the northwest of the Bradford ridge, and within the boundaries of this same property, several shallow openings had been made exposing gold-bearing ore. But the work was not sufficiently extensive to enable me to determine any facts, except that from the dip of the strata of these ore bodies, if the continuity is maintained across the trough dividing the two ridges; these last mentioned strata would underlie the ore body already exposed on the Bradford ridge.

My attention was also directed to some thin true veins cross-cutting the formation, on this northerly ridge. These vary in thickness from 6 inches to 15 inches, and pan much richer than the stratified deposits. No work has been done on any of them to show what results would follow from development. The ore is a very hard quartzite, very much stained with iron oxide, and at the surface free from sulphurets.

On the north side of Crooked Creek, the gold-bearing belt appears to widen out as you follow it towards the north-east.

The Goldberg Company having determined to their satisfaction the character, and partially the extent of the ore body, talked of making preparations to perform permanent development work, and erect a plant for treating the ore. At the present time though all work by this company has been suspended.

The ore is of a refractory nature and will not yield to treatment by ordinary amalgamation. Because while the percentage of free gold is large; yet the presence of arsenic, sulphur, with sometimes traces of antimony and copper certainly place it in the refractory or rebellious list.

Bradford Fraction, Sec. 30, T. 20, R. 10 E.—This property consists of 30 acres in the extreme S. W. corner of the section, and comprises a high ridge which extends to the north-east from Crooked Creek parallel with the Bradford ridge, I have before mentioned, and distant about half a mile to the north-west. Here I found an opening on an ore body with its line of strike nearly north-east and south-west, and dipping almost flat towards the south-east. The ore has the same appearance as the feldspathic quartzite referred to as occurring in other locations in this district. At another location on lower ground, the ore is an arseno-pyrite, somewhat resembling gray copper, but sometimes showing free gold visible to the naked eye.

These openings were not of sufficient extent at the time of my visit to enable me to form any opinion as to value, or extent.

Assays by Dr. Pratt of two samples from this property yielded $5.15 and $3.95 a ton in gold.

Bradford Ridge, N. W. ¼ of S. E. ¼ Sec. 30, T. 20, R. 10 E.—On the Bradford Ridge proper, of which the Goldberg ore body is in the south-western extension, I find more extensive prospecting work has been performed than elsewhere in the district. Several openings have been made about a quarter of a mile north-east of the Goldberg property.

The first I visited is an open cut, run into the hillside until a breast 20 feet in thickness was attained. This is composed of strata of quartzite, decomposed slate and clay ; the whole mass apparently being gold-bearing, and forming a stratified ore deposit. Prof. Aughey informed me that from three picked samples representing this entire thickness, assays showed $17.75, $18.00 and $16.50 a ton in gold respectively.

From this heading I took several samples at haphazard, some of which assayed by Dr. Pratt, of Birmingham, only yielded $7.23, $7.75, and $5.15 in gold a ton respectively.

Beyond the heading of the open cut it was found advisable to tunnel, and as the work progressed the ore became harder and the body more concentrated. At one point the strata of decomposed slate and clay disappeared, leaving a solid ore body eight feet thick. At a distance of about 50 feet from the face of the cut, the dip of the ore body becomes more inclined towards vertical; and at the heading of tunnel, 50 feet farther, it assumed an arc like shape; the ore body apparently continuing down with an almost vertical dip.

Here sinking was commenced, and had progressed to a depth of about five feet when I last saw it. The winze was in ore, but water was rising and threatened to interfere with the work unless pumping was resorted to; for which no provision had been made. The ore from this winze is highly sulphuretted and of the arseno-pyrite variety, carrying both arsenic and sulphur in combination with the gold. (The richest ore found on this ridge, so far as concerns *free gold*, is a quartzite of reddish color, very much decomposed and porous.)

The open cut and tunnel do not drift on the ore body along the line of strike, nor exactly cross cut it; but the opening has been run on an angle between the strike and dip, consequently it does not expose the true thickness of the body, and is no guide by which to estimate extent.

Other openings to the south-east of this open cut and tunnel show bodies of ore overlying or overlapping the one exposed in that opening, at irregular intervals. These are all shallow, and afford little data to base estimates on. There is one shaft which has been sunk some 50 feet. In this, one stratum of ore occurs near the bottom, and work was suspended before the entire thickness was cross cut. The shaft has not been sunk deep enough to cross cut the downward extension of the ore body exposed in the main tunnel.

The ore in all these openings bears the same general characteristics, becoming more sulphuretted towards water level. Assays yielded $5.70, $5.44, $3.99, $3.95 a ton in gold. A ten-stamp mill, fitted with stamps weighing 100 pounds each, has been run on this ore for some time by inexperienced operators. With what degree of success as to saving the gold, I could not ascertain; but from the fact that all operations have been abandoned since my examination, I am of opinion that failure resulted, as I anticipated would be the case.

A branch which flows at the south-east base of the ridge on this property has been the scene of some placer mining operations, and the gravel in its bed at places still prospects.

John Turner's Property E. ½ of S. E. ¼ of Sec. 30, T. 20, R. 10 E., N. E. ¼ of N. E. ¼ Sec. 31, T. 20, R. 10 E., also a fraction of S. E. ¼ of N. E. ¼ of Sec. 31, T. 20, R. 10 E.—I have described this property thus minutely because someoccurrences of gold bearing ore are found on each tract. The property consists chiefly of three ridges with Crooked Creek flowing between two of them; and the branch I have already referred to as on the Bradford property, forming the dividing line between the Goldberg and Turner properties, as it flows towards its confluence with Crooked Creek.

The bottoms on each side of this branch are wider between the Goldberg and Turner properties than on the Bradford. Pay gravel beds extend some little distance on both sides of this branch; but not sufficiently rich to pay for sluicing, though panning shows prospects. Crooked Creek is a bold stream with considerable fall to supply power for machinery, as it winds between the ridges, and would afford ample water for hydraulic mining besides, should investigation demonstrate the gravel bars to be of sufficient extent and value for such operations.

The ridge in Sec. 31 presents many features of interest. Although the summit is now about 100 feet above the level of the creek, yet in the far distant past, this was evidently occupied by the stream when it flowed at a higher level, before it had cut its present channel. To-day the lines formed by the receding waters are apparent, and on the highest point *iron garnets*, or limonite pseudomorphs resulting from the decomposition of pyrite, with the edges worn entirely round, as large as 45 calibre bullets can be picked up on the surface by the handful, as well as pebbles, and gravel also water-worn into rounded shape.

The surface of this ridge prospects in places, especially in the gullies on the sides; and I am informed that some fairly large nuggets have been found in Crooked Creek, near the base of this ridge.

Some shallow prospect holes expose the occurrence of an ore body of gold bearing quartz; samples from which showed colors in the pan. But the work has not been sufficient to enable me to determine the extent or structure.

Crossing the creek, I found some prospecting had been done at the south-east side and at the base of another ridge; this is the ore I have referred to as being separated from the Goldberg property by the branch which empties into Crooked Creek, and forms the dividing line. It is located in Sec. 30, and has its trend parallel to the Bradford ridge.

The work at the base resulted in exposing some ore, carrying an excess of arsenical pyrite, which assays showed was of too low grade for profitable mining. But on the crest of this ridge several shallow openings exposed a body of gold-bearing quartz of a free milling variety, which bore many of the characteristics of the quartz found in the thin veins on the Bradford fraction. By panning I obtained good results from nearly every sample I had selected at haphazard. However, the pits were all too shallow to show more than the occurrence of the ore; except but being sunk along the line of strike at frequent intervals, proved that ore-body was apparently continuous in that direction.

W. D. Mitchell's property, W. ½ N. E. ¼ and S. E. ¼ N. E. ¼ Sec. 30; also N. E. ¼ S. W. ¼ Sec. 19, T. 20, R. 10 E.—This has been prospected in several openings, and three distinct ore bodies exposed. One known as the *Pine Hill Mine* is located on the S. E. ¼ N. E. ¼ Sec. 30. This is apparently an extension of the ore body on the Bradford ridge, as it possesses all or nearly all the characteristics of that occurrence, with the same trend and dip; as well as structure of the ore body, and nature of the ore.

The work done in prospecting in the early spring of 1896 consists of one incline shaft about 80 feet deep, and some other pits of less depth along the line of strike; as well as a drift run at right angles to the shaft 40 feet below the surface. Some samples from this prospect quite richly; but a fair average showed it to be not over $5.00 ore. The drift has been run 100 feet and shows that the ore body is continuous. Cross cuts show its extreme thickness to be 14 feet, and its average not less than 6 feet, so far as exposed in the workings.

On the tract in Sec. 19 a vein, with its strike almost due east and west, and dip vertical, occurs. This possesses many of the characteristics of a true vein, but is only about six inches thick at the outcrop, widening though to twelve, within ten feet depth, and twenty-four at eighteen feet depth. This is as deep as it has been sunk on, which is hardly sufficient to determine what results further development will show. But sufficient to warrant its being classed as a good prospect; especially as the ore is free milling, and richer in the average yield than any in the district. Fifty feet to the north of this occurs another vein possessing the same characteristics as the first, and eighteen inches thick where exposed.

Adjoining this property on the north and north-west, we find the extensive beds of gneiss, in which are the flat rocks (granite), known as the Blake's Ferry flat rocks, and in which no occurrences of gold-bearing ore have been discovered.

Teakle property, *W. ½ N. W. ¼; N. W. ¼ S. W. ¼; S. E. ¼ N. W. ¼; Sec. 29, T. 20, R. 10 E.*—This property, together with some adjoining tracts located at the confluence of Crooked Creek and the Tallapoosa River, is locally known as "Hunt's Quarters,"—deriving its name from the fact, that during the war a man named Hunt bought a number of negroes from the State of Mississippi and kept them here. A series of ridges extend across this property with their lines of strike N. E. except at a few places where folding by lateral pressure has bent the semi-crystalline slate formation from the normal line. These cases are only local, and the general trend in such instances has been resumed, a short distance, from the points where deviations occur. Several prospect holes have been sunk on two of the ridges, exposing bodies of sulphuretted ore. But such are not deep enough to furnish any data; in fact, in only one or two has rock in place been reached. Consequently these bodies present the appearance of irregularly formed pockets, or masses of arsenical-pyrite and quartz without stratification.

It is claimed that at one opening, a deep shaft, known as the "Orum Pit," which was sunk several years ago, a vein of quartz bedded in the slate was discovered. This, I was informed, was enclosed between well defined slate walls; but the condition of the shaft was such, at the timeof my first examination, that I was unable to explore it. Since then, in September, 1894, I have made a second examination because of learning that such a vein had been discovered, and opened on, to the south-west of the "Orum pit" about 600 feet; which was apparently an extension of the ore body mined in that pit. I found good reasons for this theory, in the facts, that the last discovery is directly on the line of strike of the formation; the quartz carrying gold has the same general characteristics as that found on the dump at the mouth of the shaft; and the strata of country rock outcrop along the line of strike so that the continuity can be easily discerned.

At the present time—September 1894—an *arastra* is being run on this ore, a portion of which prospects richly enough to render this slow method of treatment profitable. But great care will have to be exercised in selecting the ore, which should be thoroughly roasted, before treat ment, in order to obtain the full values. This arastra was shut down later during the same year because the drag rocks were not heavy enough to pulverize the ore properly and work has not been resumed.

The ore is a hard, but not a flinty, quartzite, although the grain is fine. At the surface it pans richly in free gold, but a foot or two below is heavily sulphuretted. These sulphurets yield very readily to fire, and the sulphur is eliminated with less intense heat than is usually the case.

The openings are only shallow pits, and the ore body shows a thickness of about two feet at a depth of some eight or ten feet, with the incline of the dip. This is at an angle of about 20 degrees towards the south-east. In what is known as

Wild Cat Hollow, Sec. 29, T. 20, R. 10 E., adjoining the Teakle property on the north-east, I found some prospecting work being carried on in 1893. This is a quarter of a mile west from the mouth of Crooked Creek. A body of ore resembling arseno-pyrite in appearance had been exposed at the base of a high bluff. This will only yield any value after a thorough roast, when the gold can be separated by stiff pan amalgamation. It apparently carries no free gold, and is more refractory than any other in the district. Such may be accounted for from the fact that the ore is really from a lower level than any from other prospects.

The formation here has been subjected to such extreme folding that the line of strike is locally nearly north and south, and dip to the east almost flat.

The face of this bluff is formed by strata of Talladega slate with barren quartz intercalated; and at the point where work was in progress these barren quartz seams have, subsequent to their deposition, became auriferous. So little work had been done, though, that no idea could be formed as to what conditions would be exposed by future work.

Morris property, Sec. 21, T. 20, R. 10 E.—This is located to the north-east of the Teakle property. It consists of several ridges of semi-crystalline slate formation, peculiar to the gold districts, forming a bend of the Tallapoosa River, and on the west side. The river itself crosses the north-east quarter of this section, having a north-west and south-east course.

Some shallow prospecting work has been done exposing the occurrence of gold-bearing ore. At one point a prospect shaft 18 feet deep, exposes a body of ore 14 feet in thickness, and the bottom of the shaft is still in ore. This however, has the same irregular structure, I have remarked on as occurring at other locations in this district. The outcrop of this formation can be traced to the river, about a quarter of a mile to the north-east, at which point are shoals formed by bold and prominent ledges of slate, with quartz interlaved between the strata, but no prospecting had been done to determine whether or not it was gold-bearing. These ledges of slate ean be followed for considerable distance on the east side.—In fact the formation extends to the *Alabama-Georgia boundary line*, and beyond to an undetermined distance.

The trend of this semi-crystalline slate formation here is the same as the course of the Little Tallapoosa River, N. E. and S. W., and it continues up that river to its source in Carroll county, Ga., south-east from the Villa Rica mines.

Although in years gone by prospecting for gold has been done on this belt around Wedowee, the county seat of Randolph county, and at other localities; yet I could obtain no reliable information of the discovery of any-body of gold-bearing ore.

Most of the prospecting has been done along the N. W. edge of the belt in the vicinity of the Little Tallapoosa River. But I could learn of no location where the work had been of recent date, or of even on such a scale as in the Goldberg District. To the north of Omaha P. O. about one and a half miles, in Sec. 32, T. 19, R. 13. Mr. Joshua Ballard has prospected on a small scale, but without very encouraging results. This is on the south-east edge of the belt. The surface is plentifully covered, through that neighborhood, with limonite pseudomorphs. Some of these are quite large, and one specimen, weighing about ten pounds, when broken open was found to contain besides the pyrite, a quantity of sulphur in minute crystals, almost as fine as powdered glass.

Many stories are told, of valuable discoveries in the past, along the line of strike of this belt north-east of the Tallapoosa River below the mouth of the Little River. But on investigation I could find but little reliable authority for such. No exposures of gold-bearing ore bodies can be found for examination; except on the property of

H. S. Bradley, Sec. 30, T. 19, R. 11 E., where a ridge, apparently formed from a conglomerate deposit, occurs. This conglomerate prospects colors, and apparently carries a large per centage of limonite. The extent of this mass is considerable, but the samples I tested, carried too small a value in gold to class it as pay ore.

There is one feature with regard to the formation of this belt, especially noticeable in the Goldberg District to which I desire to call attention. It is the great abundance of limonite pseudomorphs after pyrite, (iron garnets) which are found imbedded in this semi-crystalline slate throughout the entire district. This is more noticeable though on the

Grizzle property, Sec. 24, Township 20, Range 9 E., where a line of demarcation between the slates and gneiss occurs. The surface is literally covered with these "garnets," some of which are very perfect specimens and quite large. At the time of my visit the lumps of slate, and slabs which are very thickly scattered over the surface; especially of one 40 acre tract, were being picked up, and piled to render plowing and cultivation easier. Nearly every piece of this slate contained several fine specimens of these garnets.

A vein of hard quartz, has been prospected a depth of 30 feet, this is bedded between decomposed slate and kaolin resulting from the decomposition of the feldspar in the gneiss. Near the surface some rich specimens, carrying free gold, were taken from this vein, which is however only 6 inches thick; but as sinking was continued the quartz carried much less value, indeed some of it, not even showing a trace of gold. At the point where this shaft was sunk the quartz appears to be interstratified with the gneiss and slate having its dip at an angle of about 45 deg. towards the S. E.

Resumé on the Goldville Belt.

I. The Goldville belt of semi-crystalline slates, from its extreme south-western boundary to the State line is nearly 90 miles in length, and of an average width of 6 miles; consequently its superficial era is nearly 540 square miles.

II. In the Upper Gold belt the prospecting has not been sufficiently extensive to warrant any definite determination as to value of occurrences of gold-bearing ore.

III. None of the openings except those on the Mitchell property at Pine Hill, have been made in such a systematic manner as to enable us to figure on quantity of ore in sight, and probable permanency; or even determine definitely the structure of the ore bodies.

IV. The gold-bearing ores found on this belt in the Upper field, may be universally classed among the refractory ores, although some few exceptions may be found to that rule.

V. The prospects are good enough and sufficiently promising to warrant deeper mining in many places before any judgment should be pronounced.

VI. The gold cannot be saved by amalgamation on plates; neither will concentration after amalgamation prove perfectly satisfactory. Because the specific gravity of a percentage of fine gold found in the ore, as well as of a percentage of the sulphurets is not sufficient to prevent running water from carrying such particles away with the tailings.

VII. Direct chlorination of the ore after thorough roasting or possibly treatment with amalgamator and settler by Frazer and Chalmer's process, after roasting, may prove satisfactory, and result in profitable mining operations.

Assays as returned by Dr. J. H. Pratt of Birmingham.

Number of sample.	LOCATION.	Value in gold @ $20.67 per oz.	Value in silver @ 75cts. per oz	Total value per ton 2,000 lbs.
1987	Goldberg, Sec. 30, T. 20, R. 10	5 15	...	5.15
1988	" " "	3 14	....	3.14
1989	" " "	2.56	....	2.56
1990	Jno. Turner, " "	4 59	08	4.67
1980	Bradford Fraction, Sec. 30, T. 20, R. 10	5.15	.08	5.23
1981	" Ridge " " "	5.15	....	5.15
1982	" " " " "	5.70	.15	5 85
1983	" " " " "	5.44	.22	5.66
1984	" " " " "	3.99	....	3.99
1985	" Fraction " " "	3.95	...	3 95
...	W. B. Mitchell, Sec. 1, T. 21, R. 9.	9.81	...	9.81
.	Dr. Manning, Sec. 36, T. 20, R. 9.	23.03	....	23 03
..	" " " " "	10.42	...	10.42
....	J. Walker, Sec. 29, T. 20, R. 10	5 37	....	5.37
..	Teakle, " " "	6.20	...	6.20
...	Bradford Ridge, Sec. 30, T. 20, R. 10	7.23	....	7.23
	" " " "	7.75	....	7 75
2052	Teakle, Sec. 29. T. 20, R. 10.	3.10	.	3.10

These assays were made on samples selected at haphazard, but with a view to obtain as near an average as possible, without sampling by the systematic quartering method ; for which no facilities were afforded the survey.

MICA SCHIST GOLD BELT.

Location and General Characteristics.

Leaving the Goldville belt of semi-crystalline slate to the south-east, we cross the line of demarcation and into a region of gneiss and mica schist, which extends towards the north-west as far as the south-eastern foothills of the Talladega mountains. This region embraces an area of about 1,000 square miles, and comprises within its boundaries, portions of Coosa, Tallapoosa, Clay, Randolph and Cleburne counties.

This belt also contains two distinct leads of gold-bearing ore, so far as at present known. These may be designated as the Shinbone Ridge or Kemp Mountain lead, and the Pinetucky lead.

As the last named occurs to the south-east of the first my examination was resumed on that, after finishing my work on the Goldville belt.

With regard to this mica-schist formation, I found that it did not reach as far as the Alabama-Georgia boundary line. Its north-east extremity being Sec. 24, T. 17, R. 12, about 2 miles west of this boundary line. Here it terminates somewhat in the form of the narrow edge of a wedge, and is interstratified with the semi-crystalline slates in apparent conformity. Towards the south-west it widens out and attains its extreme width in the neighborhood of Pinetucky, in the north-western corner of Randolph county, where it is nearly 18 miles wide; extending from Rockdale, Randolph county, near the centre of T. 19, R. 11 E. to Chulafinnee, Cleburne county, Sec. 13, T. 17, R. 9 E.

Details of the Gold Occurrences.

Pinetucky Gold Mine, Sec. 12, T. 18, R. 10 E.—The discovery of gold-bearing ore here was one of the earliest in Alabama, being co-temporary with the Arbacoochee Placer discoveries in the "forties." Some mining operations of a very crude character were carried on here about the same time that Arbacoochee was a prosperous typical mining camp. A volume of interesting reading could be written devoted exclusively to the early days of Pinetucky. Its changes of ownership have been numerous. Changes in the policy of the owners equally so. But up to the present time so far as I can ascertain from reliable sources, the results have invariably been partial or total failures. The blame rests to a very great extent on the shoulders of the management and owners, but not entirely so. Pinetucky is an example of what ought to be termed a rich specimen mine. The ore carrying gold is a narrow vein of hard bluish quartz, between equally hard mica schist walls. Both the gangue rock and ore are very tough and difficult to mine. The pay streak will average about 10 inches at the present depth of the workings about 60 feet vertically from the surface. Consequently the expense for mining under the most favorable circumstances, is in excess of what it otherwise would be. Add to this the fact that the vein is of lenticular or kidney structure, and the pay ore is found in chutes or chimneys, and the reasons for failures are quite intelligible, especially when the work is conducted by inexperienced miners, and mill men ; as it generally has been. This mine presents some features I have not found existing elsewhere in Alabama.

The ore body, and formation have locally an abnormal line of strike ; being nearly N. and S. with the dip to the east on a very slight incline not exceeding 10 deg. or 12 deg.*

Along the line of strike on the surface this ore body can be traced for a distance of about 1½ miles by the abandoned pits sunk in the past. The pits were sunk on the outcrop, and incline down with the dip of the ore body; the free milling or oxidized ore was mined out to water level then the pit abandoned, and a new opening made at the outcrop, to be mined out in the same manner, and in its turn abandoned. On the north and south granite veins outcrop with their lines of strike conforming to the general formation of the country N. E.—or only varying a few degrees from such a course. These veins carry mica in crystals of sufficient size to dress into sheets of commercial value.

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*Subsequent careful observations of this ore-body, at a point very favorable for getting the correct dip and strike. show that the strike is N. 30 deg. E. and the dip is towards the S. E. W. M. B.

As the vein of gold-bearing ore varies in thickness from a streak not much thicker than a knife blade, to 14 inches and sometimes exceeding that; so does it vary in richness from a mere trace of gold to the ton to $150.00 a ton. The values saved in the mill runs, in the ten stamp Fraser and Chalmers Mill erected some 5 or 6 years since, vary in much the same proportion as the assay values. One lessee claims to have saved $40.00 a ton from the ore, and $7.00 a ton from some runs on hanging wall rock. Another, that 100 tons of ore only yielded a total amount of $38.00 after costing $1,500.00 to mine. I have seen many specimens of the ore showing free gold in great splotches, and at one time I saw nearly 2 tons of ore mined nearly every piece of which was a fine cabinet specimen. I know myself of mill runs having been made which yielded $40.00 to the ton in free gold, but were limited to less than 4 tons to the run prior to a clean up.

A great deal of value has always been claimed to be carried by the sulphurets, with which the ore is heavily charged. It is impossible, however, at present to verify such a statement, because really no thorough system of concentration has ever been carried on.

Some concentrates sent to St. Louis in 1893 yielded according to Prof. Potter's assay $666.00 a ton in gold;

while other samples taken about the same time and presumably from the same pile only yielded $90.00 a ton, according to assay made by Mr. Makemson, Chemist for the Woodstock Iron Company, at Anniston. Some other samples sent to New York, a few weeks later, only assayed from $8.00 to $28.00 a ton, as returned by an assayer, for a new process for saving gold from concentrates called the "Kendall" process. Duplicates of these last were also sent to St. Louis, and the returns were approximately the same. Such results demonstrate that a very unsatisfactory method of concentration was practiced, or else that the samples were manipulated by some interested parties.

The workings in the mine to the east of the line of pits I have already referred to, consist of a vertical shaft 55 feet deep, and a drift on that level about 200 feet in length. Above this the ore has been mined out from the outcrop down; no attempt having been made to work ahead on the ore body and stope up. An incline some 10 feet in depth has been run with the dip of the vein from the bottom of this shaft, and this really represents the increase in depth in the workings for the past 20 years. In taking out ore about 6 to 8 feet of the hanging wall has always been mined out, and the pay ore streak is consequently at the floor of the drift, and almost invariably, even when mining was going on under water.

This system of mining is so crude, and unskilful, that there is no chance to estimate on ore in sight, because there is none. Had sinking been continued in a shaft located in the mill house, about 200 feet to the east of the shaft I have already described, until the ore body was cross cut, the conditions would have been very favorable for estimating the value of the property. This work would have opened up at least 200 feet of virgin ground, and reduced the cost of mining very appreciably ;

by affording a chance to stope up instead of digging down for the ore, besides hoisting it directly into the mill over head, instead of using a steer and whim to hoist with, and a team to haul to the mill. The steam hoist being afterwards brought into requisition to place the ore on the rock breaker floor.

During the summer of 1895, and since my examination reported in the preceding pages was written, further prospecting work was performed at the Pinetucky Mine. This work was done with the aid of a diamond drill. The shaft in the mill house was bored to a depth of 205 feet without cross cutting any ore body. The cores from the drill showed granite at a depth of 55 feet, alternating with the garnetiferous mica schist country rock to the depth of 205 feet where work was abandoned.

A second drill hole was bored about 70 feet to the west of the mill house, and on a line between that and the old workings. In this mica schist was passed through to a depth of 60 feet, when granite was encountered, and to a depth of 130 feet the same conditions were found to occur as in the mill house. At this point work was abandoned, and a third hole sunk to the west. This hole is 80 feet east of the old working shaft. At a depth of 47 feet after passing through mica schist, the core showed granite was encountered. At a depth of 47 feet a 4 inch stratum of feldspar was passed through, and below that the core was ore, of much the same character as in the old workings. This, I am informed, was 12 inches thick. Next was four feet of soft gouge material, which was lost from the core, because of its softness. Below this a garnetiferous mica schist, similar to the country rock occurring in the old workings, was encountered for a few feet, and below that granite again showed in the core.

The Pinetuckey Company executed a lease to the Fair Mining and Milling Company, of Chicago, to extend over a period of five years. The lessees performed the prospecting work with diamond drills, and after encountering the ore body in the third hole, commenced the work of sinking a working shaft at that point. This work is being carried on with dispatch. It is purposed to drift both to the north and south after cross cutting the ore body. Stopes will then be started, and the ore mined out to the old workings about 80 feet above, on the incline of the dip of the ore body.

I am informed by Mr. Hugh McIndoo, of Chicago, one of the lessees, that a thorough sampling of the mine in the old workings had been made prior to the prospecting with diamond drill. The assays showed an average yield of $38.00 per ton. Further tests showed that the ore was partially free milling. Some to the extent of 25 per cent., and others to 75 per cent. With regard to concentrating, I was informed by the same authority that such would result in the proportion of one ton of concentrates being obtained from 216 tons of ore.

No well defined extensions have been discovered, of this ore body, unless a discovery in a well on Sec. 13, T. 18, R. 10 E. should prove to be such. But no effort to demonstrate such a fact has been made; although the well was sunk early in 1893 by a negro, who showed quartz resembling Pinetucky ore, which he claimed he took out from the bottom of the well.

About two miles to the north of Pinetucky, the same country rock, underlying the granite veins, and conforming with their strike and dip, has been encountered; but no gold-bearing ore discovered.

To the south-west of Pinetucky on Sec. 13 the formation resumes its normal line of strike, as it also does a short distance N. E. of the workings: indeed such change occurs on the north half of Sec. 12, the gold mine being in south half of the same section.

So far as I am able to judge from the work performed, this is the most promising portion of Alabama for mining for mica. Because in several locations to be described later in this report the crystals of mica are found of sufficient size and grade to warrant the assumption that profitable results would follow systematic and deep mining.

In a north-easterly direction from Pinetucky we find a break in the mica-schist formation, where the semi-crystalline slates appear in a wedge-like shape, with the thin edge towards the south-west. The line of demarcation on the southern boundary of this semi-crystalline is about 3 miles northward from Pinetuckey in T. 17, and the point of this wedge is in the same township near the Riddle's Bridge crossing of the Tallapoosa River in R. 10 E. being the same range as that on which Pinetucky is located. The northern or north-western boundary of this wedge of semi-crystalline formation, has a north-eastern course from the river to Sec. 17, T. 17, R. 11. Here the mica-schist again occurs; in its turn assuming a wedge-like shape with the thin edge at this north-eastern point, and widening out towards the south-west. At the Riddle's Bridge a junction is formed with the main body of mica-schist which formation continues to the south-west in an uninterrupted belt.

These complications of the formation are shown in a general way on the geological map of the State, where distinction is made, however, merely between the feebly crystalline Talladega slates, and the fully crystalline schists.

I will here continue my report on the occurrences of gold-bearing ore belonging to the north-westerly belt of mica, and hornblende schists of the upper gold belt and consider those belonging to the semi-crystalline slates later in order to avoid complications.

Crossing the Tallapoosa River from Pinetucky, in a westerly direction, I found that the Shinbone Ridge, which is a continuation on the western side of the river of that chain of ridges in which is located the Kemp Mountain which forms such a prominent feature of the landscape on the eastern side of the river, with its trend to the north-east towards Turkey Heaven Mountain.

This Shinbone Ridge with its trend south-westerly, crosses a portion of Cleburne county and Clay county. It bears much the same relation to that region as the "Devil's Backbone" bears to the lower gold belt. The geology though, of these two ridges is entirely dissimilar, for while the "Devil's Backbone" is made up almost entirely of semi-crystalline slates and hydro-mica schists, the formation of the Shinbone Ridge belongs to mica and hornblendic schists. For several miles this chain of ridges occupies an almost parallel position to the Blue Ridge Mountains proper, and near the south-western extremity the trend of both the mountains and the chain of ridges is in a southerly direction. The occurrence, of gold-bearing ore, which have been discovered in the belt of mica-schists, are located in what is known as the Idaho mining district, which embraces a large portion of T. 19 and 20, in R. 7 E.

The Idaho Mining District.

This district comprises several prospects, prominent among which are the Idaho, or Franklin, the Hobbs, the Laurel, the Chincapina, the California, and the Horn's Peak; on all of which mining operations of greater or less extent have been carried on.

The ore bodies in this district occur in the ridges, which make up the chain locally designated as the Delta Divide, which in this locality really embraces a mountainous district covering quite an extensive area, and comprising several ridges or backbones lying almost parallel to each other; the most prominent being Shinbone Ridge. This belt of mica and hornblendic schists in which the gold-bearing ore bodies occur, is bounded on the north-west by a belt of altered eruptive rocks, locally termed "the copper lead," because iron pyrite, associated with chalco-pyrite has been found to occur in this rock, and mining work was carried on some years since in this locality.

The entire width of the gold bearing district which I refer to as "the Idaho District" is about three miles, and its length so far as, at present known about the same. On the north-western boundary is located a property known as the "Watts" which, in days gone by, is credited with having furnished a large amount of placer gold, and is particularly noticeable because of the vast quantities of large and well shaped garnets. So vast are the quantities of these that a portion of the property itself, is known as "Garnet Hill." Near this is a branch or small stream locally known as Gold Branch, which, history says, produced a large quantity of placer gold in the seventies. Another feature of the district is that in nearly all of the valleys formed by the creeks and branches, there occur beds of gravel at various depths below the surface which will nearly always yield placer gold from pannings. This fact has been demonstrated in several localities in this district by the cutting of ditches to drain the bottom lands.

The Idaho or Franklin, Sec. 3, T. 20, R. 7 E.—A ten stamp mill was run on the ore from this mine for several months a few years since; but work was abandoned because of litigation, and the mill and mine have remained idle since 1889, but will be started up in the near future, the litigation having been decided in 1895. The mine itself is on a ridge, locally known as "Gold Hill," which might be termed a foot hill of the Shinbone ridge, on its north-western side. Open cuts made into the side hill expose an immense mass or deposit of quartzite and micaceous graphitic schist with decomposed material resembling wad interstratified, with the strata almost vertical. The strata are very thin usually, and so intermixed that it is very difficult to obtain samples of each material separate, so as to ascertain which carries the most value. The entire mass has been quarried, and I am informed was milled without any effort to separate the products of these strata. It is difficult to form any estimate of the extent or permanency of the ore body, because the work of mining was carried on without sufficient regard to future development. Apparently the strata continue on down indefinitely, and have been mined 50 feet wide. From the summit of the ridge to the floor of the cut at its lowest depth is probably 50 or 60 feet; and a shaft was sunk in the floor of the cut several feet. But as this was full of water I could not investigate the results obtained.

A very noticeable feature about the ore body is the immense quantity of iron-alumina garnets in the gangue. In fact the occurrence of these garnets associated more or less closely with the gold bearing ores of this district, is one of its distinguishing features. Such garnets do not carry any values, so far as can be determined by panning tests, but a test by fire assay might perhaps show the presence of some gold.

The formation at the Idaho mine is nearly east and west and the line of strike is maintained for two or three miles westerly. There are at least two distinct ore bodies on this property. The most extensive being that which I have just described with another but smaller body known as the "Little Sampson" vein: apparently entirely distinct from the main body, occurs on the north-west side, and a great change is noticeable in the character of the ore which carries values. For here the quartzite itself is auriferous, and not the schist as is the case in the big or main ore body.

The work which was performed at the Idaho mine in 1888, resulted as I am reliably informed quite satisfactorily. I have during the spring of 1896, had a better opportunity to examine this property more closely than was afforded me during the summer of 1893-4, when most of my examinations on the upper gold belt were made.

Although of course the workings have caved in to a great extent consequent upon their being large open cuts and the number of years the mine has remained idle, yet I was afforded such an opportunity under the guidance of Mr. Joshua Franklin, superintendent of the property, as allowed me to inform myself more thoroughly relative to the extent and promise of permanency of these bodies.

The open cuts extend for 104 yards along the line of strike, and show that the ore body, where these cuts cross it, is at least fifty feet in thickness.* From pannings on an average of the entire ore body, in one cut, there is certainly a value of $2.00 a ton in free gold.

This value is more closely associated with the decomposed schist than with the bodies of quartzite, which have been exposed in the mine workings, but while this is the case, it is also a noticeable fact that the schist does not yield values except where closely associated with quartzite. Whether the garnets which occur as gangue yield any values, or not, is an open question.

Some of the quartz bodies exposed in the main cut are fillers of fissure veins, cross-cutting the cleavage of the schists almost at right angles, and apparently maintaining continuity as greater depths would be attained. The dip of these is almost vertical, and the thickness has increased perceptibly at the floor of the cut, from the thickness at the outcrop, forty feet above. Mr. Frank-

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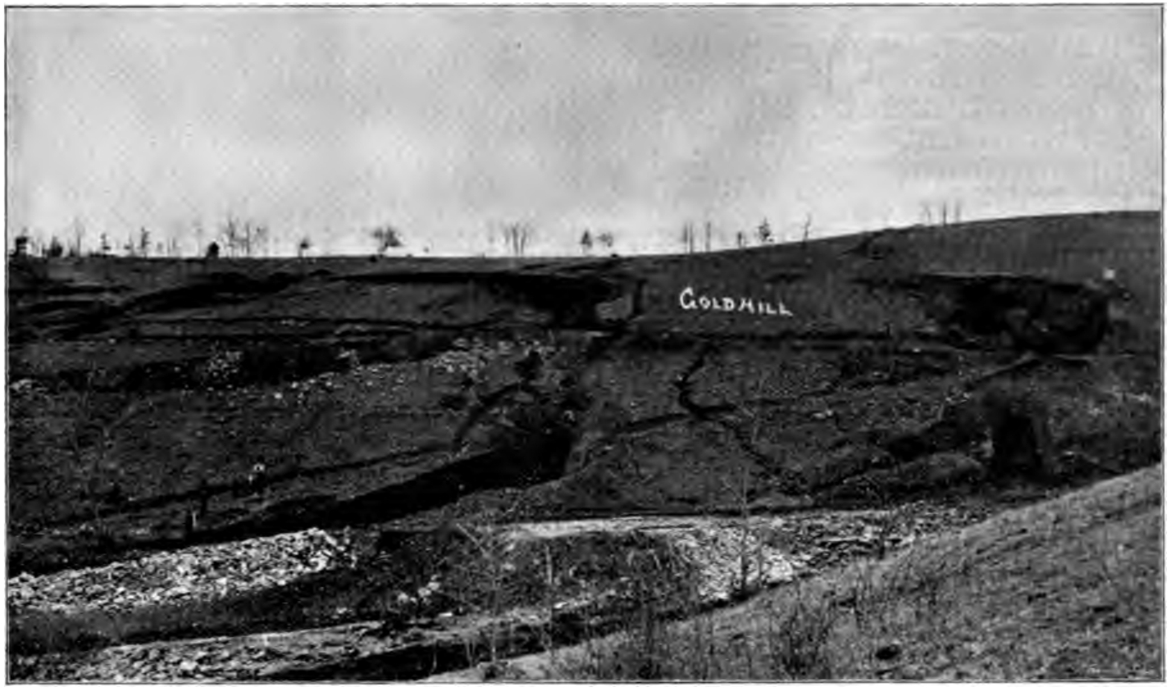
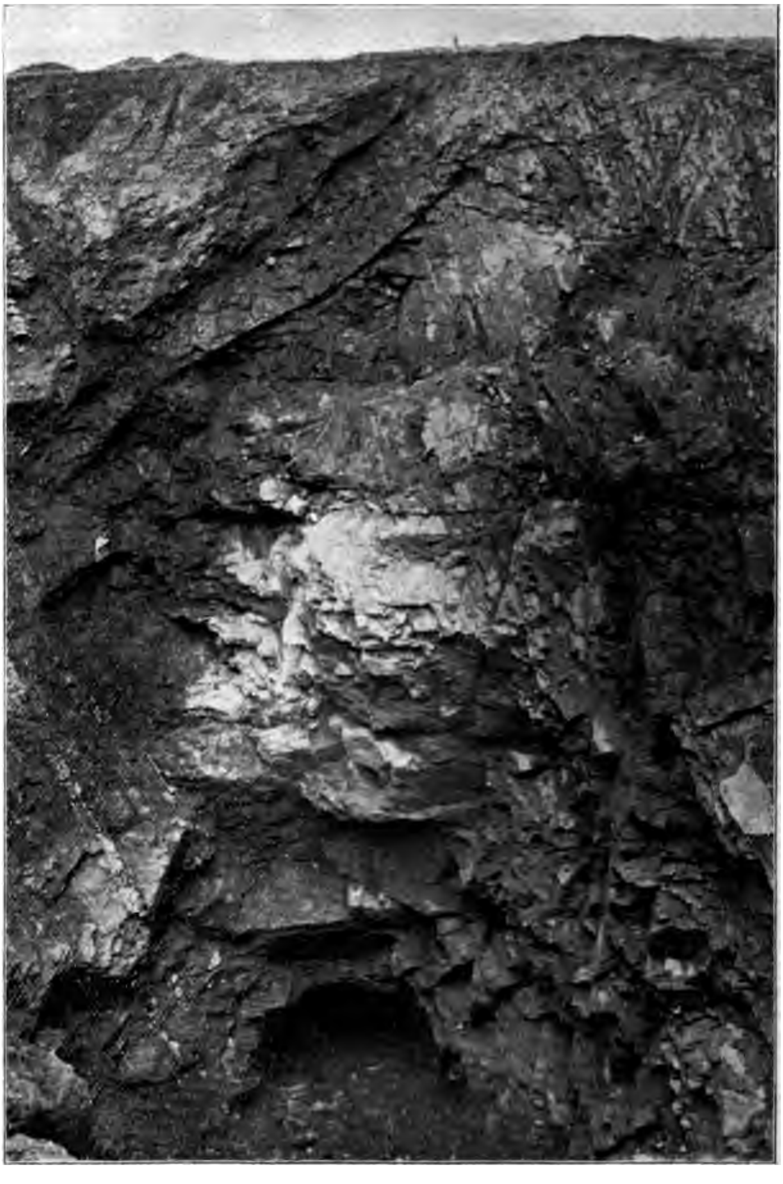
* The accompanying plates illustrate the formation and structure of this occurrence of gold bearing ore. Plate No. I illustrates all the open cuts made into Gold Hill; the Stonewall cut, on the right, the Franklin in the centre and Nelson on the left. Plate No II illustrates the Stonewall cut, showing the breast of the ore body with mouth of cross cut tunnel driven on a level with the floor of the cut. Plate No. III illustrates the Franklin cut showing conditions somewhat similar to those in Plate No. II.—W. M. B.



NELSON CUT FRANKLIN CUT STONEWALL CUT

IDAHO MINE



STONEWALL CUT, IDAHO MINE

., however, informed me that these quartz bodies carry t very little value, and indeed he did not consider such h enough to run through the mill when he was work- g the property.

The second ore body on this property outcrops a dis- ice of fifty yards north-west of the main workings. iis is referred to earlier and designated as the "Little impson vein," and has been partially prospected, but e work has not been sufficiently extensive to warrant e expression of any opinion as to the material facts.

Judging from the line of strike of these ore bodies, a eory is tenable that if the continuity of each is main- ined towards the other, the two bodies will intersect ch other; because the line of strike of the main body nearly due east, while that of the "Little Sampson" several degrees north of east.

At the time of my recent visit, Mr. Franklin was mak- g arrangements to resume active operations at the ine, and has been considering the advisability of add- g a Huntington mill to the present plant, which is a n stamp quartz mill. By doing this he expects to ob- in relief from some unsatisfactory results he expe- enced before in treating the soft ore, which has such a ayey nature that in the stamp mill it chokes the screens d interferes materially with the crushing capacity, as ell as with amalgamation, when quick silver is fed into e battery.

It is highly probable that this new plant will be run- ng on the Idaho ore before the first of July, 1896; and ie owners propose, as I am informed, to operate the roperty as a permanent investment, and with the ex- ectation of developing it into a dividend paying mine.

Following this ridge to the south-west from the Frank- in mine, I found its surface was thickly covered with ieces of quarzite, in which are embedded masses of garnets, as well as pieces of limonite, closely resembling gossan. This is characteristic of the mica-schist belt, and proved an incentive in years gone by to encourage many men to prospect quite extensively for copper ore; but in this section almost invariably without success.

The Laurel, Sec. 4, T. 20, R. 7.—The ore body exposed by shallow prospect holes on this property is apparently an extension of the Little Sampson. The line of strike though is nearly east, with the dip almost vertical, and the ridge on which this is located is an extension of the Franklin or Idaho ridge. Its continuity, though, has been interrupted by some small creeks or branches which have cut channels through it as they flowed towards Talladega Creek, into which they empty.

The character of the ore is very similar to that found in the Little Sampson; the values being found almost entirely confined to the quartzite, which can be more easily separated from the decomposed matter resembling wad and schists, than at the Idaho. Samples taken from the entire mass pan very satisfactorily; and during the summer of 1893 a miner named Stevens made fair wages sluicing the vein stone from the Laurel without first crushing it,—proving by that result that the gold is disseminated through all the material forming the vein stone of the pay streak, which is about four or five feet wide.

Work on this property has been insufficient to determine any facts, beyond showing it to be a good prospect. Mr. Steed, the owner of the Laurel, informed me he proposed, during the present year, to prospect that ore body at depth, by a cross-cut tunnel, which can be easily run from the base of the ridge so as to intersect the ore body at a depth of 50 or 60 feet below its outcrop.

A stream flowing near the base of this ridge, and having its source in the ridge, will furnish ample water for mining and milling purposes. Also for hydraulic mining should the gravel bars along its bed prove of sufficient extent and value. These have been worked by sluicing, at irregular intervals, for some years past, and in spots are quite rich.

The Chinca-Pina, Sec. 33, T. 19, R. 7 E.—This prospect is located on a ridge to the north of that on which the Laurel and Idaho occur. The line of strike of the ore body is North-east with its dip towards the S. E. at an angle of about 30 degrees. The workings consist of an open cut, crossing the formation; an incline pit or shallow shaft, and several shallow holes in which the surface soil pans very satisfactorily. These last, though, have not been sunk deep enough to expose rock in place.

The openings have been made in such a manner that no reliable estimate as to value, or permanency, or extent of the ore body can be formed. The ore is found in strata bedded conformably with the formation, having no well defined walls. The pay is disseminated through these strata in the same manner, as in the more vertical strata on the Idaho and Laurel.

Hobbs, Sec. 3, T. 20, R. 7 E.—This ore body is located on a ridge extending almost parallel to but between the ridges on which occur the Chinca-Pina and Laurel. It has been exposed in several shallow pits, and is apparently a promising prospect.

California, Sec. 15, T. 20, R. 7 E.—On this property a ten stamp mill was erected some years since, and mining and milling operations conducted. But the openings were all caved in at the time of my visit, and I was unable to explore them. Beyond the fact that the ore found in the mill, and around the old dumps, yielded prospects by panning, nothing further can be said about the property.

The Ho[illegible]s Peak, Sec. 4, T. 20, R. 7 E.—During the summers of 1893 and 1894, when I made my first examination of this district, this ore body had been but very imperfectly prospected at the summit of the peak or hill from which the mine takes its name. But at this writing , spring of 1896, a recent visit to this district, has enabled me to examine the property more thoroughly, because a considerable amount of work has just been performed and several tons of ore milled in a small five stamp mill located in the vicinity.

While this peak is really a continuation of the ridge in which occurs the ore body in the Idaho mine; it is separated from the main ridge by erosion. This ore body is located almost westerly from the Idaho mine and not quite a mile distant.

A cross-cut tunnel has been run to intersect the ore body at a vertical depth of about twenty-five feet from the summit of the peak. This work has demonstrated that the ore body is some thirty feet in thickness and several runs of a limited quantity of average ore through the mill have resulted, I am informed, in a saving of $2.00 gold per ton, by amalgamation. The ore may be styled as a garnitiferous quartzite, because of the large quantities of iron-alumina garnits embedded therein.

No work to determine the continuity of this ore body along its line of strike other than shallow prospect holes along the summit of the peak, has been yet performed. Nor has any deep work been attempted.

From the structure of the peak it would have been very easy to determine the permanency and extent of this ore body at depth of about 200 feet, by merely running a cross-cut tunnel to the ore body, and drifting along the line of the strike. Such work would be doubly advantageous too, because it would have drained the mine as well as have afforded a splendid opportunity to mine the ore by stoping. The value of the property too, would have been demonstrated beyond cavil, because it would have been an easy task to measure the quantity of ore in sight and make calculations on which the value of the property should be based.

Kemp Mountain District.

Eckles, Sec. 23, T. 17, R. 10 E.—No other discovery of gold-bearing ore has been made to the north-east of the Idaho District in the mica-schist formation on the west side of the Tallapoosa River, so far as I was able to ascertain, either by prospecting or from reliable information. After crossing the river towards the east I found prospects in many of the branches and creeks, especially on the Denman and Morrison plantations to the west of the Eckles property. But no work of any extent exposing pay ore had been done.

The Eckles property has created quite an excitement from time to time since its discovery in the spring of 1893. It was bonded during that summer for $30,000. The 40 acre tract of land on which it is located was purchased by an old prospector named Eckels for $125.00, after he had done some prospecting, the result of which was not generally known. The same tract had been offered previous to that time for a Texas pony worth about $40.00.

The prospect work consists of an open cut, crossing the formation, with a shaft some 65 feet in depth, below the floor of the cross-cut, which is about 8 feet deep. This cross-cut is nearly 50 feet in length and exposes the ore body almost that entire distance. In structure this ore body bears great similarity to those in the Idaho District; being a series of thin vertical strata of quartzite and decomposed schists, so closely interfoliated that it is difficult to obtain samples to determine which strata carry the pay. Samples taken from nearly any portion of the cross cut will yield good results without crushing the vein stone. In sinking the shaft the strata were found to maintain their vertical dip to a depth of 36 feet, here the dip changed to an angle of about 60 deg. towards the south.

A cross cut run at the bottom of the shaft showed the ore body which yielded pay, had narrowed down to 18 feet in thickness, much of the decomposed material found at the surface having apparently pinched out, leaving the strata of quartzite more concentrated. During the summer of 1894, sinking was continued on the shaft until a depth of nearly 100 feet had been attained, without any material change having occurred in the ore body.

The surface has been prospected across the 40 acres on the line of strike of the ore body, which is slightly north of east, and its continuity demonstrated. The same results were obtained on the extreme western border of the tract, but beyond this the formation has been folded several degrees to the north, and although continuous, does not yield pay where some shallow prospecting has been done on the adjoining tract.

No systematic work of treating this ore has been done, by which an average value from mill runs can be estimated. The graphite interferes with treatment by ordinary amalgamation, and the absence of sufficient water prevents working the property by hydraulic process, and afterwards milling the quartzite tailings, as is done at Dahlonega, Ga., on a somewhat similar formation.

Such a method of mining and treatment could be carried on profitably to a depth at any rate of about 40 feet; but below that the vein stone becomes very much more solid and will probably become sulphuretted near water level.

Golden Eagle, Sec. 17, T. 17, R. 11 E.—This property was originally known as the old Price mine, and prospecting work consisting of two incline shafts, one about 30 feet, the other shallower, together with about 100 feet of tunneling was performed in 1893. This work was done by some parties who held an option on the property, which however expired before any very satisfactory discoveries were made. Since then and during the spring and summer of 1894, work has been resumed by W. D. Vaughn of Heflin. Under his management an upraise was made from the tunnel to the bottom of the deepest incline shaft, and a drift some 30 feet long was run on a level with the point in this shaft (32 feet from the surface) where work was discontinued in 1893. From the discoveries made by a prospector in the spring of 1894, the first miners had quit work on the eve of exposing some very rich ore. As much of this carried free gold, visible to the naked eye, and assayed as high as $58.00 a ton, Mr. Vaughn took an option on the property and went to work at once to develop it further. He is also erecting a small stamp mill for the purpose of prospecting and sampling, that portion of the ore body which is free milling. Such is apparently the character of the ore to a depth of about 30 feet, but below that depth it can only be considered partially so because the ore is not only very highly sulphuretted, but also has the appearance which denotes that it carries a large per centage of arsenical pyrite. The deep shaft is now about 75 feet in depth, sunk on the ore body with the same incline as the dip; an angle of 50 deg. towards the south-east. The line of strike is N. E.

The vein matter consisting of quartzite and hydro mica schist is about 10 feet thick at the 75 foot level. This vein of quartzite is very much decomposed, and enclosed between what appear to be semi-crystalline slate walls, being the same character of slate as forms Turkey Heaven Mountain, which are not well defined near the surface. This occurrence of gold bearing quartzite is almost at the extreme point of the strip of mica schist formation, which forms the northern prong of fully crystalline rocks in Cleburne county. A vein of coarse grained granite is also exposed in this formation, about 50 feet south-east of the ore body I have referred to, and which should be designated as the "lower" body, because on the south-east side of the granite vein another, and distinct ore body has been exposed. This outcrop occurs paralleling the vein of granite, which is about 30 feet thick, and in apparent conformity with the general formation, both with regard to strike and dip. In fact the series occur on the surface as follows: On the north-west, the "lower" ore body, about 5 feet thick at the surface, bedded in slate much decomposed near the surface; next in order, towards the south-east, Turkey Heaven Mountain slate 50 feet; next granite vein about 30 feet in thickness, then the mica schist in which is bedded the "upper" ore body. In this ore body the gold is carried by a sandy, sugary, friable quartzite; and considering that in 18 feet, (the depth of the incline), this ore body has increased in thickness from 6 inches at the outcrop, to 2 feet at the bottom of the shaft, it is certainly a promising prospect.

In the tunnel on this property, beyond to the south-east of the point where the "lower" ore body is cross cut, an upraise was commenced by the miners who first drove this adit. In this I find that the formation above the ore body is a pyritiferous graphitic slate very hard and similar to the slate forming Turkey Heaven Mountain it is very tough on this level, which is 50 feet vertically below the mouth of the incline shaft.

The granite vein referred to apparently is intrusive, because at a point about 300 yards from the mine workings, and to the north-east we find it is only 3 feet thick at its outcrops, which resembles a big boulder, but is continuous towards the south-west; though apparently not so to the north-east, so far as the surface indications show.

The slate country rock which forms the hanging wall of the "lower" ore body belongs to the Turkey Heaven Mountain series, but that forming the foot walling has more the appearance of a hydro-mica schist, than the typical "Talladega" or semi-crystalline slate, found covering such an extensive area north-west of the Arbacoochee Gold Mining district, and extending to the south-eastern border of the Paleozoic area.

Traveling in a northerly course from the "Golden Eagle" or "Price" mine we find this hydro-mica schist extends for about 1½ miles. Beyond that point and northerly the geology is difficult to determine, because the surface of the ground is covered by pieces of quartz and soil with no exposures of the slate, until the north-east corner of section 9, township 17, range 11 E. is reached, where a narrow strip of hornblendic rock (diorite) occurs. Beyond this again in a northerly direction we find no exposures of the slates until after crossing the Arbacoochee and Bowden wagon road near the western boundary of section 34, T. 16, R. 11 E. where the typical "Talladega" slate occur.

**Results of Assays by Dr. J. H. Pratt of Birmingham, Ala., from samples taken at haphazard along the Mica-Schist Gold Belt.*

2053 Chinca Pina, Sec. 33, T. 19, R. 7 E. $1.38 per ton gold.
2062 Pinetucky, Sec. 12, T. 18, R. 10 E. $89.91 per ton gold.
2063 Geo. Hobbs, Sec. 3, T. 20, R. 7 E. $4.55 per ton gold.
*2064 Price "lower" body, Sec. 17, T. 17, R. 11 E. $2.75 per ton gold.
*2065 Price "upper" body, Sec. 17, T. 17, R. 11 E. $2 07 per ton gold.
2070 Laurel, Sec. 4, T. 20, R. 7 E. $77.10 per ton gold.
2004 Franklin, Sec. 3, T. 20, R. 7 E. $14.26 per ton gold.
1978 Eckles, Sec, 23, T. 17, R. 10 E. $8 58 per ton gold.

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*Taken from old workings previous to resumption and new work.

"TURKEY HEAVEN MOUNTAIN" OR NORTH-WESTERN SEMI-CRYSTALLINE SLATE BELT.

Gold Ridge Mining District.

This district is located in T. 17 and 18, R. 12 E. apparently in the semi-crystalline slate formation, near the line of demarcation between the mica schist belt and the slates. In fact it is immediately to the south and east of the point where the mica schist wedges out, two miles from the Alabama-Georgia line in Cleburne county to which I have before referred.

In some respects the occurrences of gold bearing ore in this district may be considered properly to belong to the Goldville Belt; for although the formation is composed more extensively of the slates found in Turkey Heaven Mountain, a graphitic variety of semi-crystalline slate interstratified with the regular semi-crystalline varieties, than is found elsewhere on that belt; yet it is really the same, when the formations are only classed as crystalline and semi-crystalline.

I can not identify the ore bodies on their lines of strike with any in the same formation to the south-west, and for that reason as well as because of the slight difference in the country rock, I have considered this district as distinct from the Goldville Belt. So far as at present prospected the quartz seams in this district rarely carry any values. The ore which yields value is a ferruginous sandstone, but several very fine specimens of sugary quartz, impregnated with free gold are reported to have been found in this district, a few years ago. Several of these I was shown by Mr. Charles Harper of Rome, Ga., who is a part owner in about 1,600 acres of land in the neighborhood. The only prospecting work of which I could obtain any knowledge has been done on this property, which comprises portions of Secs. 27, 33, 34, T. 17, R. 12 E. and Secs. 3, 4, 5, 7, 8, T. 18, R. 12 E.

I could not ascertain the exact location of this prospect work by section number, nor could I, when I examined it, determine any essential points relative to the ore body. A shallow incline shaft had been sunk exposing a body of ferruginous sandstone about 20 feet in thickness, having its line of strike nearly Northeast and dip about 45 deg. to the S. E. Samples taken from the dump panned in free gold satisfactorily, showing some $4.00 or $5.00 a ton; but the ore body itself could not be sampled because of water filling the shaft. I was informed that the entire thickness averaged as well as the samples I tested. It is claimed, work was abandoned because of the water rising in the shaft, and the owners were not in position to provide pumping facilities. Really the property was purchased for speculative purposes, and the only object of the owners appears to have been to expose an ore body, and make no attempt to develop it.

The property was purchased with the view of controlling as much as possible of the lead longitudinally, and, if development should prove that continuity along the line of strike is maintained, together with values, and continuity at depth, then this will be a valuable property. But such can only be determined by actual work, which at present has not been performed.

An analysis by Dr. Pratt showed $4.82 a ton in gold from samples taken from the dump I have referred to.

Turkey Heaven District.

From the Gold Ridge property I followed the line of demarcation between the semi-crystalline slate and mica schist towards the south-west, to the point where the slates wedge out near Riddles' Bridge, and prospected back to the north-east in the semi-crystalline formation. In this region are located the Turkey Heaven Mountains, from which the mining district derives its name.

I found that gold bearing ore occurred at several locations at and near the base of these mountains, but none has yet been discovered in the mountain itself. On its summit and sides, as well as in the formation to the south-west, the graphitic variety is interstratified with the Talladega, and other semi-crystalline slates, and all of the occurrences of ore carry a large percentage of this graphite.

Miller, Sec. 35, T. 17, R. 10.—This is the most south-westerly discovery of gold bearing ore in this Turkey Heaven District. It is located only a short distance from the point where the slates wedge out, and are displaced by mica schist.

A few shallow prospect holes have been sunk, and a body of sandstone exposed, a portion of which carries gold. This ore is found to occur under a limonite capping, and I could find no evidences of well defined walls to indicate vein structure. The barren, and value-carrying ores appear to be interstratified, and form a deposit, with its dip towards the south.east, and on only a very slight incline.

The work has been insufficient to base any estimates as to value of the prospect, but the indications point to there being a large deposit. I base this opinion on the showing in a number of shallow prospect holes sunk along the line of strike and from the outcroppings, which prospect some colors.

Crown Point, Sec. 19, T. 17, R. 11.—To the north-east of the Miller property about 2 miles distant, considerable work has been done, and a five stamp mill erected on the Crown Point mine. No systematic mining has been done here, although a small quantity of ore was run through the mill in 1893. But the value saved was insufficient with such limited crushing capacity to produce profitable results. Consequently work was abandoned, before the value of the prospect, or extent of the ore body was determined.

A sample assayed by Dr. Pratt showed $3.23 in gold a ton. From this property the leads of gold bearing ore apparently follow the flanks of the mountain, one on the south-eastern and another on the north-western. Along the southern flank but little prospecting has been done, and such failed to expose any promising prospects. The work though was quite limited in extent, and if pursued systematically may yet result in the discovery of gold bearing ore bodies.

Moss-back, Sec. 35, T. 17, R. 11 E.—This was one of the early gold discoveries, made during the copper excitement early in the "seventies." The outcrop and ore near the surface yielded very fair results, as I am informed on reliable authority; but deeper mining operations appear to have resulted disastrously, jndging from the fact that both mine and mill have been deserted for years.

Two incline shafts were sunk on the lead of ore, one exposes an ore body 8 feet thick bedded between walls of a talcoid graphitic schist, or decomposed slate, resembling schist in appearance; the other an ore body 18 inches thick, bedded in the same country rock.

The last mentioned, was known as the "Houston" shaft, and I am informed the ore taken from it yielded by mill runs from $4.00 to $4.50 a ton in free gold. The first mentioned, was known as the "Company Shaft." This was considerably deeper than the "Houston," being some 30 feet. The ore taken from it was of lower grade than from the other, but the cost of mining the thick ore body was of course less than the thin; which ought to have offset the difference in value.

A vertical shaft was sunk, with a view to cross cut the ore body exposed in the "Company" shaft at greater depth. While the work was progressing, I am informed, that the superintendent reported that the gold bearing ore had given place to copper bearing ore. He shut down the mill, and abandoned mining operations at once, and the same condition of idleness exists to-day. I was unable to explore the workings because of water, so can not verify my information by a personal examination.

A good ten stamp mill was erected on this property in 1890, and for several months quite extensive mining and milling operations were conducted.

Pritchard, Sec. 36, T. 17, R. 11 E.—Here an incline shaft some 15 feet deep, has been sunk for prospecting purposes, and about 7 feet of strata of auriferous sandstone, or quartzite has been exposed. This is bedded between talcoid graphitic decomposed slate or schist walls, with a slightly inclined dip towards the south-east, and its line of strike nearly north-east. By panning an average sample from the entire thickness this proved of low grade, about $3.00 a ton; but by selecting samples some very rich results were obtained.

Lucky Joe, Sec. 25, T. 17, R. 11 E.—This property is located to the north-east of the Moss-back and nearly north of the Pritchard, distant about three-quarters of a mile from either. Although, at the point that active mining operations were carried on in 1893, the formation on this property is contorted from the normal line of strike North-east to an abnormal line nearly due north yet I am inclined to class the Moss-back and Luckey Joe as belonging to the same lead of quartzite. Although I have never actually followed the outcrop of the formation, from location to location, yet the evidence of folding by lateral pressure is so well defined, by the crooked lines of the strike of the slates on the Luckey Joe property, and the resemblance in the ore so marked, together with that of the country rock, that I feel convinced development will prove the correctness of my theory. But I doubt very much if the lead, should its continuity so far as formation is concerned be proven, will maintain any continuity so far as being gold-bearing, is concerned.

Development in the Lucky Joe has already demonstrated that the pay ore is found in chimneys or shoots in the ore body. The property was first opened in 1893 to a notable extent, and a ten stamp Fraser and Chalmer's mill erected thereon, with all the latest improvements. But as it proved later, the management had committed the fatal mistake of erecting this plant before the property was sufficiently prospected to prove that a mine actually existed. Consequently the first clean up was not satisfactory, and all work was abandoned for several weeks. Later, after more extensive prospecting, other mill runs were made, which preved more encouraging; having demonstrated that $2.27 a ton could be saved in gold, by amalgamation. The cost of mining and milling, I was informed by the Superintendent (an experienced miner from Colorado) was $1.35 to $1.45 a ton. The capacity of the mill using 30 mesh screens, being 30 tons a day, together with the other facts I have mentioned, insured profitable results from mining and milling, provided that sufficient quantity of ore of that grade could be mined.

During the summer of 1894 I made a thorough examination of this property, because the success or failure were matters of vital importance to the gold mining industry of the state; and I wanted to determine, if possible, whether, in spite of partial failure due to the mistake made at the commencement, the condition of the property was such as to indicate future successful results.

I found, as I have already stated, that the pay ore lay in chimneys or shoots, which occurred through the so-called ore body, of varying width and thickness. Therefore, while the vein matter is apparently quite extensive, yet only a limited portion carries values; consequently, during the first milling operations a large number of tons of barren material, having the appearance of pay ore, were milled. This, of course, reduced the yield of the ore itself to an insignificant figure.

The vein matter is a garnetiferous quartzite interstratified with a decomposed talcoid slate or schist, and by panning I ascertained that sometimes the value is in the quartzite, but more often the decomposed material pans the richest. The workings consisting of 300 feet of drifting and cross cutting show that the chimneys of pay ore are about four feet wide and three to four feet thick, dipping towards the east on about a 30 degree angle, with their line of strike a few degrees west of north These ore shoots lie almost parallel to each other, and up to the time of my visit three of them had been exposed. The centre one of these is wider than the others, and apparently the main channel, towards which the narrower shoots appear to be trending. The work being done at the time of my visit was to determine whether these shoots did actually concentrate to one main body of pay ore. A winze was being sunk from the 50 foot level, on which all the prospecting has heretofore been done, to determine the extent and permanency of the widest shoot at a greater depth.*

Smith and Wood's Old Copper Mines.--Paralleling the Pritchard ore body on its western side occur the old copper mines, worked in the early "seventies" I can only refer to these from information I could gain in the neighborhood, because all work has been abandoned for several years past, and the openings made at that time are all full of water to-day.

It is a matter of history that both these properties produced considerable copper 20 years ago. The ore was smelted in soapstone furnaces, the ruins of which still remain as land marks. This soapstone was quarried near by, from a ledge which occurs in the neighboring crystalline formation.

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* A few weeks after my visit work was suspended again, and has not been resumed since to date, April, 1896.—W. M. B.

From the appearance of the water flowing from the old workings, the mines were evidently not entirely worked out, because scrap iron will precipitate copper in short time, and in considerable quantities. Some of the ore must evidently be fairly rich. From the most reliable information I can gather, the work was abandoned because of the average low percentage of copper, and excess of iron pyrites. The ruins of the plants, old dumps and general appearance of the surroundings indicate that quite extensive operations were carried on during the days of copper excitement. Between this group of mines and the state line to the north-east no occurrences of gold-bearing ore have been discovered.

Leaving the neighborhood of this group of mines, and traveling towards the north-west across the thick edge of this semi-crystalline belt, we cross the eastern flank of Turkey Heaven Mountain. No discoveries of any importance of gold-bearing ore have ever been made, until Section 2, T. 17, R. 11 E. is reached. We pass the

Head Mine, Sec. 13, T. 17, R. 11 E., on which considerable work was done a few years since, without resulting in any discoveries worthy of note, and I only mention it in this report to show that in my examination I have not neglected to notice any properties on which discoveries are claimed, or prospect work of any extent performed.

Hall, Sec. 10, T. 17, R. 11 E.—Some shallow prospect work has been done on this location, but such was not attended with any promising prospects being discovered, and is mentioned for the same reason.

**Hicks-Wise, Sec. 2, T. 17, R. 11 E.*—A greater vertical depth has been reached in the workings in this mine, and a more extensive ore body disclosed than at any in Alabama at the present period. A shaft, almost vertical, has been sunk 110 feet, or 27 feet below water level. About 3,000

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* The present period referred to is the summer of 1893.—W. M. B.

tons of ore have been mined and milled from levels run from this shaft, at 20 feet, 40 feet and 85 feet from the surface. It is claimed that this ore yielded $2.00 a ton by amalgamation. It can hardly be classed as free milling ore, although no other treatment has been attempted. Because of the percentage of graphite it carries from the surface down, and the sulphurets below water level, amalgamation will never save full values.

The line of strike is Northeast with an almost vertical dip towards the S. E. The structure of the ore body can hardly be considered as determined. In the soft decomposed slates from the surface to water level, it has all the appearance of a mass of ferruginous sandstone, quartz and decomposed slate with the appearance of a stratified deposit of unknown depth, and width. At the 85 foot level (the deepest work I could examine, because of water and no pumping facilities), this ore body has been drifted on a distance of about 200 feet, and maintains its continuity; but at no point has it been cross cut to determine its extreme thickness. Both headings of the drift are in ore. A cave which occurred near the surface, shows a thickness of ore 25 feet, but whether that is the maximum can not be determined.

Assays on the Hicks-Wise I am informed by Mr. Julius Houston of Arbacoochee, show its value to increase from $2.00 a ton at the surface to $14.00 at 110 feet, at which point the sulphurets ran as high as $39.00 a ton. These assays I was informed were made by W. M. Courtis a mining engineer and chemist of Detroit, Mich., who made an expert examination of the property in 1893. Other assays are given below.

Lee Mine, Sec. 2, T. 17, R. 10 E.—This property was purchased in the spring of 1894, by a syndicate of capitalists from Cincinnati; and extensive prospecting work commenced.

The line of strike of the formation and ore body is Northwest with the dip slightly W. of S. at an angle of 45 deg. It has all the characteristics of a bedded vein between slate walls, which are well defined, better in fact than at almost any location I have examined in the State. The varying thickness of ore in a drift at 40 feet from the outcrop, on an incline conformable with the dip, is between 4 and 5 feet. An incline shaft has been sunk about 40 feet, from the surface down with the dip, where a cross cut tunnel from the south side of the ridge in which the ore body is located, intersects the bottom of this shaft. A drift 121 feet in length has been run on this level, in ore the entire distance, with ore in both headings, and nearly 80 feet of the drift showing the ore body to maintain its continuity at its maximum thickness. From the level of this drift an incline has been sunk 20 feet, showing the ore body to be 5 feet 6 inches thick at the bottom.

The plant at present in operation for treating this ore comprises three arastras, and a Blake crusher. The superintendent, Mr. S. Fohr of Cincinnati, informs me that by this treatment, he has demonstrated that the ore will mill $5.00 a ton in gold.

A fair average sample I took myself from the entire thickness of the vein as exposed at 15 feet deep assayed by Dr. Pratt of Birmingham, yielded $12.61 a ton in gold. The thickness of the vein at the point from which I took my sample was 2 feet 6 inches.

Crumpton, Sec. 7, T. 17, R. 12 E.—The occurrence of gold bearing ore discovered on this property, has not been prospected sufficiently to determine whether any ore body beyond the mass of outcrop, and irregular "blow out," as it may be termed, really exists. The ore is the same ferruginous quartzite, in the "Talladega" semi-crystalline formation, as that occurring in the Lucky Joe and Mossback: but the country rock shows less of the graphitic variety of slate than that in which those mines occur. However, as the line of strike on the Crumpton has its normal trend Northwest and the property is located on a direct line geographically, with those mines I have mentioned, I believe I am correct in classing it as a possible extension, subject of course to determination by actual prospecting. Some of this ore pans very richly, especially that from some strata which are less ferruginous than the bulk of the ore.

Middlebrook, Sec. 3, T. 17, R. 12 E.—This property is located in the north-east corner of the north-west quarter of the section. The ore body is interstratified with the formation, having its strike North.east and dip South-east conformable with the country rock, the same "Talladega" semi-crystalline as is typical of this section of the gold fields. The ore is a ferruginous quartzite, and the body is capped with limonite. An incline shaft has been sunk about 20 feet deep showing a thickness of pay ore nearly 5 feet; from which I obtained not less than $5.00 a ton in gold, by panning an average sample taken from the entire thickness.

Ballinger, Sec. 2, T. 17, R. 12 E.—An occurrence of gold bearing ore, similar in character and at the outcrop of about the same relative value from pan tests as the ore found on Crumpton property, about 3 miles S. W., was discovered on this property several months since, but no attempt to develop or even prospect the outcrop has been made.

Sutherland, Sec. 34, T. 16, R. 12 E.—Here a body of gold bearing quartzite has been quite extensively prospected. This ore body, while bearing in some particulars, as to the stratified structure, a close relationship to the Middlebrook, yet may prove by development to be confined between well defined walls. Certainly it has a well defined slate hanging wall, but no solid foot wall has been yet exposed, unless a stratum of decomposed slate, should prove such. The slate hanging wall has faulted at the depth of about 30 feet below the surface, and threatens to cut off the ore body entirely, in one incline shaft sunk on an incline of about 45 deg. to a depth of 30 feet. At this point the fault in the slate was encountered and work suspended. The ore body had maintained a thickness of nearly 4 feet above this, and prospected very satisfactorily.

There are two other incline shafts, one 25 feet in depth, the other 15 feet.

The deepest of these two exposes nearly the same thickness and grade of ore, as in the first shaft mentioned. But in the more shallow pit, two bodies of ore which at the outcrop, near the pit, appear divided or separated by strata of decomposed slate have united, and the body of quartzite has an aggregate thickness of nearly 12 feet. But what proportion of this yields values I am not prepared to state.

Ore from this property has been milled in a temporary stamp mill constructed of wood throughout; except clumsily made iron shoes. The stamp stems are made of 4 in. x 4 in. scantling. The cam shaft, a log squared, about 12. inches through. The cams are cut, with great ingenuity and fastened into this log. The tappets were wooden pegs set in augur holes bored through the stems.

The results from milling in such a primitive manner, would hardly prove a fair test of the ore; even if such could have been obtained, which I found impossible.

Bennifield, Sec. 27, T. 16, R. 12 E.—This property has been prospected by several shallow open cuts, exposing the occurrence of gold bearing quartzite. This has every indication of being a stratified deposit, covering considerable area of undetermined thickness. The ore would be classed as low grade, so far as my tests by panning, without taking a sample in a thoroughly systematic manner, could be relied on. Some other shallow prospecting has been done in the neighborhood, but not sufficient to base any estimate on as to extent, value or permanency. More extensive work should be done, before any determination as to the value of any of this district can be arrived at. In fact the same proposition applies to the entire State so far as gold mines are concerned.

Marion White, Sec. 6, T. 16, R. 12 E.—In this same "Talladega" slate formation, and to the north-west of the quartzite bodies just referred to, and within a short distance of the Georgia Pacific Railroad in Cleburne county, occur a few prospects, which are promising enough to warrant the performance of more work than has already been done. The most important of these discoveries is on the Marion White property, over which in 1893, there was considerable excitement because of some quite rich quartz specimens being found in which the free gold was visible to the naked eye. These were found as float. Prospecting exposed a thin vein of quartz with lenticular structure bedded in the slates, which also panned fairly well. But a sample which was assayed by Dr. Pratt only yielded $2.27 a ton in gold. The work was not of sufficient extent in the neighborhood to warrant the expression of an opinion.

James Moore, Sec. 12 and 13, T. 16, R. 10 E.—This property is some 6 miles south-west of the White prospect. Placer mining of considerable extent was carried on in this neighborhood as well as on this particular property some years since. Sluicing in a ditch recently yielded some fairly coarse particles of gold quite rough, and ragged on the edges, denoting it had not been washed far. But for placer diggings the ground would not pay, and some little surface prospecting failed to expose any quartz body or vein bearing gold. Indeed, although the surface of the ground, through several properties in this settlement, is plentifully covered with float quartz, decomposed and porous to some extent, and plentifully stained with iron oxide, yet no ore body, or outcrop or even float carrying gold could be discovered.

Resume on the North-western Semi-Crystalline Belt.

I. The extent of this belt so far as the formation is concerned, and not including the Terrapin and Talladega Mountains, which, while the formation is the same, I shall treat separately, because the ore bodies in these mountains occur on the north-west slope, and consequently really belong to a separate and distinct belt, is about 18 miles long with the line of strike, and 24 miles wide across the formation at its widest part, and contains about 300 square miles.

II. The ore through the entire belt is a sandstone, or ferruginous quartzite, which were it not for the presence of graphite, and sulphurets below water level, might be classed as free milling of low grade.

III. A few of the prospects such as Hicks-Wise's Crumpton's, and Middlebrook's may prove to be comparatively free milling; and permanent development work may result in profitable operations.

IV. Deeper work is warranted on most of these prospects examined, because of the rich results obtained from many, from the outcroppings, and the fact that so far as work has progressed the ore has maintained its continuity in value.

V. The permanency, and extent of these ore bodies, can only be proven by deeper and more systematic prospecting; while the values can only be determined by thorough test and sampling, by the various treatments known to science.

Results of Assays by Dr. J. H. Pratt, of Birmingham.

2058 Lee Mine, Sec. 2, T. 17, R. 11 E. $12.61 gold per ton, no silver.
2068 Gold Ridge, Sec. 34, T. 17, R. 12 E. $4.82 gold per ton, no silver.
1966 Hicks-Wise, Sec. 2, T. 17, R. 10 E. $3.14 gold per ton, no silver.
1967 Hicks-Wise, Sec. 2, T. 17, R. 10 E. $4.30 gold per ton, no silver.

HILLABEE (IWANA) GREEN SCHIST BELT.

A belt of light green colored, highly pyritiferous, altered eruptive rock occurs paralleling the "Talladega" slate proper of the Talladega Mountains, on the south-eastern edge; and apparently maintaining its continuity along the line of strike, from the Coosa River, near the mouth of Weogufka Creek, towards the north-east into Cleburne county.

This rock is distinguishable from the "Talladega" slates by the large percentage of unaltered pyrites it carries, as well as by its massive structure, hardness and toughness. These last characteristics cause it to be very difficult to drill and blast; while the quantity of crystals of pyrites imbedded in it has proved in the past very attractive to prospectors for copper ore. At the present day it is receiving attention from the prospectors for iron pyrites for treatment in the acid plants, in converting such into sulphuric acid.

With what degree of success this class of mining will be attended in Alabama, is impossible to determine at this early date; because the industry has not passed beyond the age of infancy.

The Chulafinnee and Arbacoochee Mining Districts

in Cleburne county are located on the south-eastern border of this formation. As early as 1842 placer mining was carried on in these districts very extensively. Especially was this the case with regard to Arbacoochee, when the town bearing that name was a typical placer mining camp, in all that the name implies. The stories of big nuggets, and rich pockets or beds of gravel, are to a certain extent facts, proven by the returns from the Mints, in which Alabama is credited with producing $365,300.00 in gold between the years 1799 and 1879, the bulk of which came from this district. I group these districts under one head because they are in the same geological formation, the continuity of which is maintained throughout. While Chulafinnee is located about 10 miles to the south-west of Arbacoochee, and across the Tallapoosa River, yet from a miner's standpoint the relationship between the two localities is so close that I am justified in classing them under one head; although I shall consider the occurrences of gold-bearing ore and gravel in each separately.

The Chulafinnee Mines are located, so far as at present discovered, in Secs. 14, 15, 16, 23, 24, 25, T. 17, R. 9. E. The most extensive placer mining in the past was done on these tracts, through which the waters of Chulafinnee and Carr Creeks flow.

Judging from the extent of the tailing dumps and workings, the gravel beds must have been quite extensive. But these have been worked out where profitable, and to-day some five or six feet of surface soil have to be removed to reach gold-bearing gravel, which will pay an average of 75 cents a day to the man by sluicing. Consequently these cannot any longer be considered as paying placer mines, though the formation would warrant investigation with the view of adopting hydraulic mining, and such might prove profitable because the gravel beds exposed under the soil are apparently of considerable extent.

So far as quartz mining is concerned, but little work has been performed, except at the

King Mine, Sec. 16, T. 17, R. 9 E.—Here a stamp mill was in operation in the "seventies;" but work was abandoned, it is claimed, because of litigation. The old openings show that mining was carried on quite extensively; but it is impossible to form any estimate of the extent of the ore body, because the deeper shafts are filled with water, while the shallow openings have been abandoned so long they are filled with debris. In one pit, near the surface, I was enabled to expose a seam of hard white quartzite about six inches thick, having a N. and S. strike, and dipping nearly vertically towards the E., bedded in strata of decomposed schist. This, however, could hardly have been what the owners were working, because it only assayed $1.03 a ton in gold.

From the extent of this pit, the mouth of which covers an area of some 2,500 square feet, it would appear as though the country rock had been milled, as well as the thin strata of quartzite.

Striplin, Sec. 22, T. 17, R. 9 E.—Here sufficient prospecting has been done to show the occurrence of a body of gold-bearing quartz of irregular structure, characteristic of such outcrops as miners designate as "blow-outs or burst-ups."

The shallow openings were made on the summit of a ridge, extending N. E. and S. W. between the head waters of Carr Creek. The gravel in both of these branches is gold-bearing, and the old dumps and pits show that placer mining of extent was done in the past. Sufficient depth was not reached in this prospect work to determine any facts relative to extent, value or permanency.

On the south-east slope of this ridge another pit some eight or ten feet deep exposes some narrow stringers of a white sugary quartzite, with a north and south strike and almost vertical dip towards the east, bedded in strata of decomposed schist, apparently the same as occurs in the Arbacoochee mines. This prospected fairly well by panning without crushing, thus showing that the gold from the quartz had been disseminated through the decomposed schist, to some extent.

The quartz in this prospect I preserved after panning, and by assay it yielded $3.31 in gold a ton.

Samples I took from several outcrops assayed between sixty and seventy cents a ton in gold.

A discovery has been recently reported (Sept., 1894) as having been made on the

Higginbottom Property, adjoining the Striplin on the north-east. The ore body resembles the thin strata of quartz and decomposed schist described as occurring on the Striplin land. It pans very richly at the surface, and is sufficiently promising as a prospect to warrant the performance of work, to prove its extent and value at depth.

Between the Chulafinnee mines and Arbacoochee mines no discoveries of gold have been made. In fact, I can learn of no prospecting work of recent date that has been done; although the formation maintains its continuity and gold can be panned out of the gravel in nearly any of the creek beds or gullies, in small quantities.

Arbacoochee Mines, Sections 5, 6 and 7, T. 17, R. 11 E. These sections, I learn from information, as well as observation, judging from the old dumps and workings, furnished all the gold credited to Arbacoochee in the old days of placer mining.

To-day there are spots on either of these sections which yield profitable results from sluicing, and a large area would pay for hydraulic mining, provided water could be obtained in sufficient quantity, and pressure by gravitation.

On section 5 hydraulic mining has been carried on at irregular intervals for several years past. But as no record of the yield has been kept, it is impossible to make any reliable estimate of the amount of gold cleaned up. Traditions are related which, however, cannot be sufficiently reliable to base any statistics upon. Many of these place fabulous values on some pockets and beds of gravel washed out in the past. Nuggets ranging in value from $1.00 to $1,300.00 are claimed to have been found by different miners at various spots throughout the entire district.

There is one feature which deserves attention, and it is the fact that at no point has solid formation been reached in the old workings. The bed rock has been considered to be a red clay* which underlies the gravel beds. These gravel beds occur in pockets about three feet in thickness, and very close to the surface, on a ridge, which apparently was the bed of the creek, which has since cut its channel to a considerable depth below the summit of this ridge.

To determine the present value of these hill "diggings," as they may be termed, would require a vast amount of time and actual work, which the survey is not prepared to devote to it.

In 1893 an expert examination was made by W. M. Courtis, of Detroit, Mich., of a portion of *Sec. 6, known as the "Denson" property*. This expert informed me at that time that the value of the placer ground on a portion of the section was 20c. a yard. However, he gave me no figures as to extent, which, of course, would be most important. But as to water facilities, he informed me it would be necessary to bring the supply from the Tallapoosa River, the nearest point being about two and a half miles.

Considerable prospecting for quartz veins has been done in this district with varying results. But no plant has ever been erected to treat any of the gold-bearing quartz, although several veins (usually thin) have been exposed in the prospect pits, which yield good results. Some very fine free gold specimens, the quartz carrying the gold being of a whitish sugary nature, have been found both as float and in some of the vein stone.

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*This "red clay" is in many places seen to be merely the thoroughly decomposed rock, the "saprolite" of Prof. Becker. See also Report of Alabama Geological Survey for 1874, p. 44. E. A. S.

The maximum extent in width of the Arbacoochee gold-bearing gravel belt is attained on sections 5 and 6, where it is fully one mile across from the northwestern to the southeastern boundaries. One very noticeable difference occurs in the country rock on the north-western side of this belt and that on the south-eastern, or rather in the formation which parallels this "Iwana" rock formation on the north-west, and that which parallels the placer district on the south-east. The "Talladega" slate beyond the north-western boundary is less crystalline, and carries no "iron garnets" (i. e., altered pyrites); but apparently the same type of slate beyond the south-eastern body is very highly garnetiferous, and almost fully crystalline, graduating into hydro-mica and mica schists further to south-east. Another appreciable difference is that the formation to the north-west for a distance of at least five miles is, so far as at present known, entirely non-mineral bearing; while on the south-east it is gold bearing.

In following the Arbacoochee belt towards the north-east and along the Trickem Valley, I found that less regularity existed in the maintenance of its width than is the case to the south-west. Although towards the south-west the pay diggings are found to occur only in spots, yet the formation maintains its continuity and average width yielding colors generally where any gravel is washed, beyond the recognised limits of the placer diggings; but not sufficient to warrant its classification as pay dirt.

Hence, while the formation is continuous from Chulafinnee to Arbacoochee, it is only on the tracts I have particularly referred to that pay diggings really occurred.

Near and below water level quicksand occurs in this formation through the northerly portion of the district, but in the southerly hard bed rock is reached at shallow depth.

In a north-easterly direction from Sec. 5 the placer belt diminishes in width very rapidly, and near the north-west corner of Sec. 2, T. 17, R. 11 E., it is entirely lost, so far as the State of Alabama is concerned; at least, so far as is at present known from the prospecting that has been done.

During the summer of 1895, the Hilton Brothers and R. E. Merrill obtained an option on 200 acres of section 7, and the first named a lease on 20 acres of the Denson property on the west half of section 6, and immediately adjoining section 7 on the north side. This action was based on a tradition of a very rich find made by a man named Marable in the "forties," in the placer ground drained by Clear Creek. The father of the Hiltons had marked the location of this find, and bequeathed the knowledge to his family before his death. The understanding was, that at any time the brothers could obtain an option or lease on the property he designated, that they should work it for the benefit of the family. Tradition said that Marable had taken 11¾ lbs. of gold from this pit in a half day, celebrated his discovery by a carousal, during which he died. The pit in the meantime had filled with water, and had not been disturbed since that day in the "forties," until the summer of 1895.

After prospecting for some weeks the ore was encountered, together with a large quantity of gold dust and nuggets. The most important feature of this discovery was the auriferous quartz in place. A dispute arose between the owners of the properties relative to the land line as soon as the discovery was made, which caused the suspension of operations at that particular point. When work was stopped, a fresh fracture in the quartz in place showed native gold imbedded in it, in sufficiently large particles to be visible to the naked eye 20 feet distant.

The country rock proved to be a gneiss,* in which the auriferous quartz was bedded, the strike and dip conforming, so far as seen, with the structure of the country rock. Sufficient work had not been done to determine the structure of this ore body, or its permanency. In thickness it was about six inches.

The result of this discovery was the performance of a large amount of prospecting work by a Chattanooga syndicate to which the Hiltons had sold their option. This was done at several points on section 7, and is being carried on at the time of making this report.

Other adjoining properties shared in the activity and the entire district changed its aspect from one of abandonment to one of life.

T. H. Aldrich of Birmingham optioned the east half of section 6, or the Creamer property, as it is locally called. He commenced a systematic method of prospecting to endeavor to discover the rich ore body to the north-east along its line of strike. Several cross cut trenches were dug, and at two points the ore body, or what was apparently the same, was cross cut. These were located about 1,000 and 1,700 feet, respectively, from the Marable. If these belong to the body discovered by the Hiltons, then there is every reason to believe that a series of faults occur in the formation which have thrust the body from its normal line of strike, because where discovered by Mr Aldrich, the auriferous quartz is 600 or 700 feet north of the normal line of strike. This theory is tenable from the fact that in a shaft sunk 30 feet south, of the Marable pit, a well defined fault is seen, and in a pit sunk a few degrees west of south of the Marable pit, a few feet distant, and on the line of strike of the ore body, such was not exposed. If the ore body was continuous, it must have been exposed in this pit.

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*See Mr. Brooks' notes, Part II of this report. E. A. S.

The same country rock as is encountered in the Hiltons' workings is found to extend through the east half of section 6 to the north-east, as well as through section 7 to the south-west, and is apparently about 800 feet wide. This is a gneiss, and further examination proves that the same character of country rock is continuous through this as well as the Chulafinnee mining district on the opposite side of the Big Tallapoosa river, crossing that river in the vicinity of Denman's bridge. Several bodies of auriferous quartz, of low grade, at the outcrop, cross the east half of section 6, but have not been prospected beyond its lines.

The Anna Howe, Anna Howe Extension and Crutchfield ore bodies form the north-western boundary of the placer diggings, and undoubtedly have furnished a great deal of the gold found in those diggings.

Although the outcrops of neither the Anna Howe nor the Crutchfield can be traced above the surface to the south-west beyond the west line of section 5, with sufficient clearness to establish continuity along the line of strike, with any of the quartz bodies in the Chulafinnee district, yet from the similarity in the relations of the two, I am of opinion that the ore body at the King Mine in Sec. 16, T. 17, R. 9 E. is really an extension of the Anna Howe.

In Coosa county some 60 miles or further to the south-west, in the same formation, (Talladega slate, close to the Iwana or Hillabee schists) we find the old *Parson's Mine, Sec. 4, T. 23, R. 17 E.*, which was worked quite extensively 4 or 5 years since. Here we have a narrow quartz vein with lenticular structure bedded in the slate, having its strike N. E. and dip towards the S. E. at 45 deg. When I visited this mine, in company with Dr. Eugene A. Smith, during the summer of 1894, we found it impossible to determine any facts with regard to permanency, extent or value of the ore body. The old pits and dumps, open cuts, and deep shafts denoted that the mining operations had been on quite an extensive scale; but not performed systematically, or apparently with any view to development for future mining. The idea being, as it seemed to me, to obtain what ore could be got as cheaply as possible, and let the workings fill up with water or cave in.

But to return to the *Anna Howe Extension, Sec. 34, T. 16, R. 11 E.* and *Crutchfield on the same section*, in fact a portion of the same property.

The ore of the last named has been discovered at no other points except on this property, and on Sec. 3, T. 17, R. 11 E.

The abandoned pits along the line of strike of this ore body on Sec. 34, are evidence of the work done in the past, when as I am informed some $2,500.00 was taken out of the vein, which varied from 4 in. to a foot thick, from shallow pits. These were sunk 10 or 15 feet on the dip of the ore body, which lies almost flat, dipping towards the south-east. All the ore that could be worked out, without timbering or danger from caving, was mined. That pit was then abandoned for another, to be in its turn worked out and abandoned, until the line of pits reaches for nearly half a mile in a course slightly north of east.

On Sec. 3, T. 17, R. 11 E. known as the Valdor property, a shaft about 10 feet deep has been sunk on an ore body, apparently an extension of the Crutchfield. An ore body or bedded vein, having lenticular structure, and varying in width from 4 inches to a foot has been exposed. This dips to the south, lying almost flat, and has its line of strike N. W. at this particular spot. But on Sec. 34, the vein has the normal line of strike general in the Alabama gold fields N. E. Except that the ore has the same appearance, and in general characteristics, except strike and direction of dip; these ore bodies bear strong resemblance, bnt I can not determine positively that the Valdor is an extension. The fact that the line of strike of the slates changes on the *Anna Howe, Sec. 33, T. 16, R. 11 E.* makes a strong presumption for the theory in favor of the extension.

The Anna Howe itself was one of the first gold bearing quartz discoveries in the Arbacoochee district. It is a segregated or bedded vein of highly sulphuretted white quartz, plentifully stained with iron, and partially porous and decomposed. From the surface down, a distance of about 100 feet, on an incline with the dip of the vein, the country rock enclosing this ore body, had much the same appearance of decomposed schist and quicksand as is found in the placer diggings. But at that depth this gave place to the solid "*Iwana*" or *Hillabee* schist walls, highly pyritiferous, carrying crystals of unaltered pyrites, in quite large cubes, as well as forming a large per centage of the entire mass of slate. When this solid formation was reached, I am informed, that the vein pinched out entirely, and further work was abandoned.

That portion known as the Anna Howe was sold to a syndicate composed chiefly of New Orleans capitalists, who organized as the Anna Howe Gold Mining Company. A Huntington Mill complete, with Frue Vanner concentrating table attached, was erected, and treatment of the ore commenced and continued until, as I have already stated, work was abandoned when the ore pinched out. Since that time the mine has remained idle, and the workings and incline shaft are full of water. The prospectus of this company signed by George D. Stonestreet, Mining Engineer, and Member Am. Institute Mining Engineers, is certainly a work of art, so far as estimates with regard to extent and permanency of the ore body is concerned. He figuring on 190,728 tons of ore in veins, and 297,000 tons of placer gravel in sight approximately, as well as figuring on the yield of a profit of $6,646,857.00, or 40¾ per cent. per annum. As an actual matter of fact, it is absolutely impossible to figure on any ore in sight, even under the most favorable circumstances. Because, as I am reliably informed and as the extension shows, the ore body has that irregular lenticular structure, on which it is very unsafe to form any estimates regarding the quantity of ore in sight, even when the mining is of such a character as will enable any estimates to be made. Besides this, the ore body at its thickest was only a narrow seam, as is shown on the extension. I call attention to these facts not to condemn any particular man or property; but because I consider it against the best interests of the state for such perverted and exagerated statements regarding the facts to be published and circulated.

About the same time that the Anna Howe was sold, and the company organized, a syndicate of Birmingham and New Orleans capitalists purchased the *Extension on Sec. 34, T. 16, R. 11 E.*, and organized another company. Active mining operations were carried on for a while, which were chiefly confined to the Crutchfield vein which I have described earlier in these pages. No plant was erected by this company and work was abandoned when the same course was pursued at the Anna Howe mine proper.

Recently work has been resumed on the extension, by a lessee; who pumped out an old shaft sunk in 1877 and continued sinking in order to cross cut the ore body at depth in the solid formation and prove the conditions there existing. After sinking for several feet, and attaining a depth of some 60 feet from the surface, the water became of greater volume than the capacity of the pump, and work on this was suspended. The only results demonstrated were the extreme hardness of the "Iwana" and rock, that the percentage of pyrites carried by that rock, did not increase to any marked extent as the sinking progressed.

The lessee then re-opened an old tunnel and incline which had been abandoned when mining was discontinued. From this opening he succeeded in taking out about ten tons of a highly sulphuretted quartz, somewhat decomposed and porous in spots, as well as being plentifully stained with iron oxides. This he attempted to mill and treat by amalgamation, saving the concentrates with blankets. He informed me that he succeeded in saving $175.00 from the ten tons; besides the concentrates, of the value of which he was unaware. From the appearance of the ore, and all the general characteristics of the formation, this is certainly an extension of the Anna Howe vein. The ore body is only a few inches in thickness, and has the lenticular structure, and almost flat dip, typical of this district in the quartz veins.

On Section 5, T. 17, R. 11 E., an ore body resembling the Anna Howe vein has been exposed in a shallow prospect hole, but sufficient work to determine its extent had not been performed at the time of my visit. Some of the ore near the surface, after being thoroughly roasted and treated by stiff amalgamation, yielded about $30.00 a ton in gold. This ore though is not adapted for any treatment other than barrel chlorination or smelting, or possibly the cyanide process.

The line of strike of the Anna Howe vein is irregular, and by actually following the formation I found it assumed a zigzag course. Consequently it is found, especially towards the north-east from Sec. 34, to change from North-east to North-west several times within a few miles. Near the north-west corner of Section 2, T. 17, R. 11 E., it assumes its normal line of strike; but near there it is apparently cut off by a fault, and together with the placer belt is lost to the north-east so far as Alabama is concerned. From the geological conditions surrounding the locality, there is foundation for the theory that the Camille Mine in Haralson county, Georgia, is the north-east extension of the Anna Howe ore body.

Assays.

Assays by Dr. J. H. Pratt, of Birmingham, Ala., on samples from the Chulafinnee and Arbacoochee Districts, resulted as follows:

2049 King Mine, Sec. 16, T. 17, R. 9 E., $1.03 in gold per ton.
2051 Valdor, Sec. 3, T. 17, R. 11 E., Crutchfield vein, $5·17 a ton in gold.
2054 Striplin, Sec. 22, T. 17, R. 9 E., $3.31 a ton in gold.
2057 Anna Howe, Sec. 33, T. 16, R. 11 E., $12.40 a ton in gold.
1976 Reeves' Shaft, Sec. 6, T. 17, R. 11 E., $2.40 a ton in gold.
1977 " " Sec. 6, T. 17, R. 11 E., $2.36 a ton in gold.

TALLADEGA AND TERRAPIN MOUNTAINS.

Riddle's Mill. *On Sec. 16, T. 19, R. 6 E.*, in Talladega county, near Waldo P. O. or Riddle's Mill, there is an occurrence of gold-bearing quartz. This is on the north-western flank of the Blue Ridge Range of Mountains, locally known as the Talladega.

The ore body is a white quartz, highly sulphuretted, and having its line of strike North-west, with its dip almost flat, and towards the S. E. The structure is that of a bedded vein, of lenses or kidneys of gold-bearing quartz; with its continuity maintained with depth, so far as mining has exposed to the depth reached, not to exceed 100 feet on an incline with the dip of the ore body. But in the connection found to exist between the lenses or kidneys, the thickness of the streak pinches to a mere trace; while these kidneys rarely exceed four inches at the thickest part. The value of this quartz varies from $20.00 a ton in gold to $150.00 by assay test. The country rock is the "Talladega" variety of semi-crystalline slate.

Some fabulously rich pockets, I am informed, were discovered at and near the outcrop. At one time a syndicate from Birmingham, Ala., mined and milled the ore for about 6 months; but work was abandoned because of the inability to save values by amalgamation.

A system of concentration was also adopted but proved unsatisfactory. Since then several local miners have from time to time leased the property, and sometimes made good wages with a pan, pestle and mortar, by crushing the surface ore, and panning it. During the summer of 1894, Mr. Walter Riddle one of the owners, milled the ore mined by lessees, in a small mill with light stamps, with some degree of success.

The continuity of this vein is maintained along the line of strike with well defined regularity, for a distance of some two miles to the south-west from the north line of Sec. 16. Mining of considerable extent but in a primitive method has been done on the Riddle property, and the prospect pits extend for over half a mile.

On the Woodward tract in Sec. 16 and adjoining the Riddle the same ore body has been prospected to a limited extent.

In a south-westerly direction from this last mentioned prospecting, the vein crosses Talladega creek, and can be followed by the float and outcrop of the country rock to the old

Story Mine, Sec. 17, T. 19, R. 6 E. where quite extensive mining operations and some milling were carried on several years since. The ore was mined from the surface down, on an incline with the dip some 60 feet. At the heading, and where exposed along the sides of this incline, the ore body shows the same characteristics as on the Riddle, and Woodward properties.

Towards the north-east I can learn of no successful prospecting in this formation having been done.

Some 3 miles to the north-east of Ironaton, a Mr. Seay the original owner of the Clifton Iron Company's ore lands, has prospected for years for silver. His prospecting work is founded on the traditions from the Indians, in which he apparently has implicit confidence; because although his work has invariably resulted in failure yet he persists in continuing his search.

Further to the north-east in the Terrapin Mountains and in the same "Talladega" semi-crystalline slate formation, but on the extreme north-western edge are occurrences of quartz. These, or rather some of these, I find by prospecting carry a little gold at the outcrop, but not sufficient to warrant, in my opinion any investment of capital, to develop. But no work of any extent has ever been done. The quartz seams bear a strong resemblance to those around Waldo, and are impregnated with crystals of iron pyrites, sometimes measuring nearly an inch across the faces.

Graphitic slate.—There are indications of a deposit of graphite on *Sec. 2, T. 13, R. 11, on the Treadway plantation.* A short tunnel run into a bed of graphitic slate, highly pyritous, several years since has exposed such a deposit. It is possible that further work might result in exposing a deposit of solid pyrite.

Assays.

Assays by Dr. J. H. Pratt show the following results:
1993 Riddle's near Waldo, $35.97 a ton gold; 83 cts. silver.
1994 Woodward's $145.83 a ton gold; $1.58 silver.

MICA AND KAOLIN DEPOSITS—UPPER BELT.

There are, as far as my observations have reached, associated with Alabama gold belts, four distinct belts of granite veins carrying mica, and feldspar. Their commercial value, and importance, are to-day almost entirely speculative, because of the limited extent of the mining operations, as well as crudeness of the actual work done in the past, and shallow depth attained in the workings.

The feldspar is found, so far as present development shows, usually in a state of decomposition, or as kaolin. This result of decomposition has been promoted by the action of the carbonic acid of rain and other waters, which removes the alkali; also by that of the organic acids which the decomposition of plants or animals contribute to such waters.

While apparently several quite extensive beds of this kaolin exist at some points along the mica belts, yet at present the extent is unknown, because no systematic work calculated to determine such has been performed.

On the Denman property, Sec, 21, T. 17, R. 10 E., the indications are that a bed exists capable of producing a sufficient quantity of high grade kaolin, to warrant the erection of a plant for the manufacture of fine porcelain, in the vicinity of Heflin in Cleburne county, on the line of the Georgia Pacific Railroad 8 miles distant from the mines.

Several tests have been made of this kaolin as to grade; and ware has been manufactured from it. This, I am reliably informed, was pronounced equal to any ware manufactured from the imported China clay.

The only vicinity where feldspar, in crystals, sufficiently hard and pure to possess a commercial value, has been discovered, up to the present time, is in the neighborhood of *Hissop P. O. in Coosa county.*—There a fine body of considerable extent has been mined and some sample shipments, made to the Standard Coal and Coke Company of Brookwood, Ala. Such has been successfully used in the coal washers for bedding by that company, and will probably lead to the establishment of a new industry in the State, *i.e.* prospecting and mining feldspar.

The mica bearing belts are apparently south-western extensions of those of North Carolina and Georgia. Although their continuity can not be traced from the north-east by the surface indications, yet we find from the geological formations, and geographical locations that this theory is tenable and warranted.

The most northerly location of any mica of commercial value occurs on

Sections 23 and 21, T. 17, R. 11 E.—While the surface indications are very encouraging on these properties, yet but little work has been done in developing the discoveries, and no estimate as to permanency or value can be made.

To the south-east from these sections, and near the northern boundary line of Randolph county, occurs what I consider the mother ledge, so far as Mica and Kaolin are concerned.

This belt attains its maximum width in *Randolph county, in the vicinity of Pinetucky Gold Mines.* In this vicinity the width is about five miles; but to the north-east and south-west, while the continuity of the granite veins is maintained an undetermined distance, the width of the belt, so far as at present known, is much less.

Surface indications of mica deposits, of commercial value, occur along the lines of strike of the Pinetucky granite veins both to the north-east and south-west, at several points. Especially so is this the case in Clay county. But in no other portion of the crystalline region of the state have I found deposits, where the prospects for obtaining mica of a commercial value, cover such an extensive superficial area as do these.

The most extensive mining operations have been carried on at the properties of *Miller, Sec. 1; Phillips, Sec. 1; and Merrill, Sec. 12, T. 18, R. 10 E.*

From all of these properties mica has been mined and shipped for use in stoves and furnaces. Samples have also been sent to the leading electrical companies for test as to quality for their use. Such have been pronounced by experts as being thoroughly well adapted for use for electrical purposes.

Good surface indications and outcrop occur on the *Ayres and Linville properties in Sec. 19, T. 18, R. 11 E.: also on the Messer land, Sec. 18, T. 18, R. 11 E.; White's, Sec. 6, T. 18, R. 11 E.; Crews' Sec. 30, T. 18, R. 11 E.; Lander's Sec. 22, T. 18, R. 10 E.; and on several other tracts of land in this same neighborhood, owned by the Birmingham Banking and Trust Company of Birmingham, Ala.* These last mentioned tracts form a portion of some 30,000 acres purchased a few years since by Dr. Caldwell and associates, when it was expected that a railroad would be built through this portion of Randolph county.

Shallow prospecting pits have been sunk at several locations on all these tracts; but the only deposit which has been sunk on below water level is on the Merrill property, adjoining the *Pinetucky Gold Mining property.* There water came in and interfered with the sinking of a shaft at 55 feet below the surface. Below this point the size of the mica crystals, and grade of the sheets after the crystals were split, were superior in a marked degree to that taken from nearer the surface.

No mining calculated to show the extent or permanency of the veins in which the mica is found has been done at any of the prospects. The only object apparently in view when work was in progress, being to take out all the mica in sight without any regard to future development of the properties. Consequently the result has been such as renders it absolutely impossible to estimate with any degree of reliability the extent, permanency or value from material in sight. There are in all probably 30 veins which carry mica in crystals of sufficient size to warrant being prospected, occurring on the strip of which I have given the width as five miles. Many have not been prospected at all, and all of which have been prospected only carry mica in paying quantities in spots. Actual shipments have only been made from a very few mines, and such only in limited quantities.

To the south-west and across the Tallapoosa River on this belt there has been very little work done prospecting for mica, feldspar or kaolin. The surface indications at some points near the village of Delta show that good mica may possibly be found if prospected for.

About five miles north-west of Lineville the outcroppings show good indications of the occurrence of mica, but samples I have seen from the vicinity show too much iron stain to render the mica adaptable for electrical uses, and the work is too shallow to assist in determining its quality at depth. Some little work has also been done on Lundy Mountain, near Chandler's Springs, and fairly good mica obtained.

The third belt occurs on the extreme south-eastern border of the Mica-schist gold belt. In and around *Rockdale, in Randolph county*, considerable prospecting work has been done, but the work has been abandoned some years since, and I can obtain very little information regarding the results. The properties on which this work was done form a portion of the land owned by the Birmingham Banking and Trust Company, to which I have before referred.

The fourth belt of mica deposits occurs paralleling the south-eastern edge of the Silver Hill Gold Belt, in Tallapoosa county. To this occurrence of mica I have already referred in my report on the Silver Hill belt. It is impossible to obtain reliable statistics as to the quantity of mica which has been mined in Alabama up to the present time; but the extent of the work done at the mines is so limited that the output must necessarily be also limited.

There are many pre-historic pits of considerable depth and extent found in the vicinity of some of the mica deposits, where trees of large dimensions have grown on the old dumps, and in the bottoms of the pits. But when such work was done, or whether the incentive for the work was mining for mica or feldspar, cannot be ascertained to-day

PART II.

SUPPLEMENTARY NOTES ON THE MOST IMPORTANT VARIETIES OF THE

METAMORPHIC OR CRYSTALLINE ROCKS

OF ALABAMA;

THEIR COMPOSITION, DISTRIBUTION, STRUCTURE, AND
MICROSCOPIC CHARACTERS.

A. A GENERAL ACCOUNT OF THE CHARACTER, DISTRIBUTION, AND STRUCTURE OF THE CRYSTALLINE ROCKS OF ALABAMA, AND OF THE MODE OF OCCURRENCE OF THE GOLD ORES.

BY

EUGENE A. SMITH.

The gold region of Alabama occupies a triangular area in the eastern part of the state, bounded by a line entering the state from Georgia five or six miles south of the parallel of 34 deg., running thence south-westward to Jemison, in Chilton county, and from that point through Wetumpka to Columbus, Ga. In this area are included parts or all of the following counties: Cleburne, Clay, Talladega, Coosa, Chilton, Elmore, Tallapoosa, Macon, Lee, Chambers and Randolph, aggregating about 4,425 square miles in area. It is the termination towards the southwest of what has been termed by Prof. G. F. Becker, of the U. S. Geological Survey,* the Georgia belt of the Southern Appalachian Gold Fields.

THE ROCKS.

These are practically all *metamorphic* rocks which, considered from the point of view of their origin, fall into two classes, viz., those derived from sedimentary or fragmental rocks, and those derived from igneous rocks. Until recently, all metamorphic rocks were considered as belonging to the first of these classes, the planes of schistosity passing for the bedding planes of the original sediments, but modern petrographers have shown that through the agency of crust movements accompanying the upheaval of mountains, etc., the massive igneous rocks may be crushed and sheared in such a manner as to produce in them planes of easy cleavage or schistosity, in appearance similar to the bedding planes of the altered sedimentary rocks. By the same agency, planes of cleavage or schistosity may be developed in the sedimentary rocks also, and these secondary cleavage planes may or may not coincide with the original bedding planes. By the study of thin sections of rocks by means of the microscope, it is possible in many cases to determine whether or not a given specimen is made up of water-worn or rounded fragments, i. e., whether or not it is of sedimentary origin.

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*Reconnoissance of the Gold Fields of the Southern Appallachians, in the 16th Annual Report of the Director of the U. S. G. Survey.

In other cases it may be impossible to determine even this much without closely examining a large number of hand specimens, or better still, extended observations in the field. It must be understood, therefore, that the assignment here given of our metamorphic rocks to one or the other of the classes named, is not by any means to be considered as final, since they have as yet been comparatively little investigated in the light of modern methods.

Similarly as regards the age of these crystalline rocks, they cannot be brought into a single class, for the Talladega slates, being sedimentary, must rest upon still older rocks, whose debris has furnished the material out of which they have been built up, and in the gneisses and some of the hornblendic schists we probably have the representatives of this older class. Again, the diorites, granites, and other intrusive rocks which fill the fissures in this older set, are of course more recent than the rocks which they traverse. The Talladega slates, in their turn, in places apparently enclose masses of intrusive granite, which by consequence would be younger than they are. So, taking the great country-forming series, the gneisses and the Talladega slates, we have the representatives of at least two distinct eras, and in the intrusive rocks possibly a third, although part of these may be contemporaneous with the Talladega series.

In the present state of our knowledge, the older gneisses must be classed with the *Archæan*, while the Talladega slates will probably be assigned to what the Geologists of the U. S. Survey have named the *Algonkian*. One can, however, hardly avoid the suspicion that some of these semi-crystalline slates are no older than the Cambrian, although as yet the fossils have not been found to prove it.

The bulk of the eruptive rocks also will probably have to be assigned to the Algonkian.

1. ALTERED SEDIMENTARY ROCKS.

Ocoee, or Talladega Slates and Conglomerate.

Distribution.—As regards their surface distribution, the Ocoee or Talladega rocks are found in four or five roughly parallel belts, running with the general structure of the country, i. e., north-east and south-west. The main belt is that which lies furthest to the north-west, and borders the Cambrian and Silurian strata of the Coosa Valley. This belt has a width of five to ten miles according to locality, and it appears as a range of mountains with some of the highest elevations in the state. The names Blue Mountain, Talladega Mountain, Rebecca Mountain, etc., are applied to this range in different parts of its course, Talladega Mountain being the most generally applicable name. This range entends through Cleburne, Talladega, Clay and Coosa, into Chilton county where it passes gradually below the sands and clays of the Tuscaloosa formation of the Cretaceous.

The other areas of Talladega slates are found as narrow strips in the midst of the gneisses, much as though they had been accumulated in troughs of these rocks, yet other, and possibly more probable, explanations of their present attitude may be given. Two of these interior belts, as they may be termed, are wider and more persistent than the others, and of these, the one lying nearest to the main mountain belt, i. e., furthest northwest, is the more important. This belt extends through Coosa, Tallapoosa, Randolph and the lower part of Clay. It widens and ramifies towards the northeast in Randolph county, and it may be called the Goldville belt, since it includes Goldville, Hog Mountain and other localities formerly much worked for gold.

The next belt may be followed from near Eclectic, in Elmore county, north-eastward through Tallapoosa into Randolph, and through it to the Georgia line; but in the eastern part of Randolph its limits are not so clearly defined as they are in the rest of its course. In this belt occurs the Silver Hill gold mining region which was formerly much worked, and we name it accordingly.

There are in addition to these, two minor belts of altered sedimentary rocks, viz., one in Coosa county running north-eastward nearly through Rockford and merging into the main mountain belt beyond Goodwater; and one in Lee county, extending from Farrall's Mill by Wright's Mill to Chewacla and Springvilla lime works, beyond which it has not as yet been certainly identified. This will be mentioned again in connection with its most characteristic rocks, the crystalline dolomite.

Rocks of the Talladega Series.—The most abundant of the rocks of this series is a smooth, nacreous, *clay slate*, or *argillite*, of brownish gray, to greenish colors, feebly crystalline, and in places very closely resembling some of the variegated shales of the Montevallo series of the

Cambrian formation, and there are localities near the contact of the Cambrian with the Talladega, where the Cambrian shales, being slightly altered, are almost identical in appearance with some of the Talladega slates. Such partly altered shales of undoubted Cambrian age may be seen along the line of the L. & N. R. R. below South Calera, and in the vicinity of Clear Creek and Jemison; in the Kahatchee Hills in Talladega county; and further north-east in Calhoun county near Davisville; and in Cleburne in many places near the line of contact. In the north-western belt of the Talladega slates there is another series of more highly siliceous rocks, viz., *quartzites* and *quartzitic conglomerates*, constituting a very considerable part of the mountain ranges, interstratified with the greenish and grayish slates, and well exposed where Talladega Creek makes its way through the Talladega mountain, as well as in all the gaps and along the summits of these mountains. These strata, like the others, have generally a decided dip to the south-east, but along the summits they appear to be nearly horizontal, making occasionally broad flats which support a fine growth of grasses, and are admirable grazing places for sheep. One instance of this flat summit is in the mountain which ends to the south-east in the Pulpit Rock, on the border of Clay and Calhoun.

The quartzites and conglomerates like the slates above mentioned, resemble very strongly some of the strata of undoubted Cambrian age, and it is impossible to resist the conclusion that some of the strata which we have included among the Talladega slates are nothing more than altered Cambrian shales, sandstones, and conglomerates. As yet, however, it has not been possible to discover any fossils in these altered rocks.

In the Kahatchee Hills, and the other localities above named, the sandstones and conglomerates of the Weisner horizon are in appearance almost identical with some of the conglomerates and quartzites of the Talladega series.

In the other areas of Talladega slates lying further to the south-east, the strata are sometimes more decidedly altered than in the first belt, and are often much more decayed, holding numerous crystals of garnet and tourmaline.

In the *Turkey Heaven Mountain* region in Cleburne, we find a very well defined variety of these semi-crystalline schists consisting in the main of quartz but containing a large percentage of graphite and magnetite. These schists are of a dark slate blue color, with glistening surface, sometimes smooth and rubbing off on the fingers, sometimes hard and sandy. Through the dark blue black mass of the slates pass thin sheets of white quartz, giving the appearance of some of the banded diorites.*

Slates of this formation *impregnated with graphite* are common in many localities. Thus between Millerville and Elias, in Clay county, the soft slates are so highly impregnated with graphite as permit them to be used, in one locality near Millerville, for lubricating purposes. This belt is continued on towards Goodwater, where it is seen at several points in the railroad cuts. To the south-westward the same belt may be followed entirely through Coosa county, and another similar belt parallel with this passes through part of Coosa a short distance north of Rockford.

In the Silver Hill region graphitic slates appear in great force, suggesting by their color the name of one of the gold mines, Blue Hill. The graphite here opposes a very serious obstacle to the profitable working of the gold.

Another well defined variety in the rocks of this formation is formed by the *highly fissile blue black slates* resembling roofing slates, which are generally met with along the eastern flank of the Talladega mountain range, a well known occurrence being near Chandlers springs.

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*Mr. Brooks has described one of the rocks of this kind, No. 2 of his article.

Limestones, or rather *dolomites*, have been observed in two positions only in these areas, viz: (1.) On the southeastern flank of the main slate belt of the Talladega Mountain at two localities, viz., (a) near Elder P. O. in the northern part of Clay county, where it is associated with the smooth greenish and gray slates above mentioned, and (b) in Chilton county in the river bluff not far from the mouth of Yellow Leaf creek. In these localities the dolomite is not much altered, but in the other belt (2), in Lee county, the dolomite is in part fully crystalline, white, and like the finest statuary marble, in part however, bluish and gray and less crystalline. These dolomites are closely associated with quartzites.

Near Wright's Mill, four miles from Auburn in Lee county, is the southernmost outcrop of these dolomites, formerly extensively worked for lime burning at the old Echols and Reese quarries. The dolomites occupy a narrow valley about a quarter of a mile broad, with a ridge of slaty quartzites to the northwest, and with *augen-gneiss* both to north-west and south-east.

At this place the rock is gray to blue in color, varying in composition from an almost pure dolomite to a rock containing a good deal of siliceous and micaceous matters. Some miles to the north-east of Wright's Mill is the Lime Kiln of the Chewacla Lime Company, where the dolomite is taken from a large open pit or quarry. Here there is a very large proportion of the white fully crystalline rock, along with some that shows bluish and grayish colors, and is very slightly crystalline. The quarry is in an open field in which there are few, if any, outcrops of the country rock, and so it is impossible to give much information concerning the associations, although, judging by what may be seen further towards the north-east at Springvilla and the new quarries, the same associations prevail as at Wright's Mill, viz., itacolumites or slaty quartzites immediately adjacent to the dolomite, and *augen-gneiss* both to the north-west and to the south-west of the lime belt. Some details concerning the *augen-gneiss* will be found below in connection with what is said about the next series of rocks of this area.

Structure and attitude of the Talladega slates.—As a rule these beds have a dip to the south-east, the exceptions to this being very few.

In some parts of the Talladega Mountain range we find at the summit of the highest ridges, broad areas of nearly horizontal beds of quartzite and conglomerate, and in general the strata of these summits are much less inclined from the horizontal than they are on either flank, and it becomes thus at times impossible to resist the conclusion that some of these ridges are anticlinal arches overturned towards the north-west, the flat rocks at the tops being the crowns of the arches. In the ridge of which the Pulpit Rock is a part, this structure is perhaps better shown than elsewhere. In the interior belts the dip is almost invariably to the south-east. Prof. Tuomey speaks of the dolomite at the Chewacla quarry being nearly horizontal in bedding, but I have been unable to convince myself of this, as the rock is traversed by several joint planes making it very difficult to identify the true bedding plane. And wherever the quartzites with which the dolomite is associated are clearly exposed as at Wright's Mill, and the New Quarry near Springvilla, they are seen to stand nearly vertical, and it is probable that the dolomites also partake of this attitude.

2. ALTERED ROCKS OF IGNEOUS AND UNDETERMINED ORIGIN.

These, in the order of their relative abundance, include the gneisses and the mica schists, to which are subordinated the granites, diorites and various hornblendic, pyroxenic and chrystolitic rocks occurring as dikes, together with the alteration products of the same, soapstone, talco, serpentine, etc.

These rocks represent more than one geological period, for those which occur as intrusions in the others, must necessarily be younger than the rocks which they traverse. We are not, however, yet in position to make definite classification as to age of these fully crystalline rocks, except in a few cases; we shall therefore limit ourselves to general statements concerning them.

1. *The Gneisses.*—These in structure vary from nearly massive granitoid rocks to fine grained mica schists. In most cases which have come under my observation, the granite "flat rocks" show traces of cleavage planes nearly perpendicular. Along the borders of these granite-like masses, the schistosity increases and the granite grades into gneiss. The grading of gneiss into mica schist is generally effected as shown below through a series of alternations of the two rocks, each maintaining its own character. The cleavage planes of the gneisses and other schists coincide generally with the structure of the Appalachian region in this state, the strike being in general about north-east and south-west, with slight variations. The dip also is in the majority of cases to the south-east; but there are exceptions, as will be seen below. Thus north-west of the Silver Hill slate belt, as above described, the dip of the strata is almost invariably to the south-east, while to the south-eastward of this belt the variations are more numerous. A *synclinal axis* may be followed easily and almost continuously from the vicinity of Tallassee, in Elmore county, past Walnut Hill in Tallapoosa county, crossing the railroad between Dadeville and Camp Hill ;thence north-eastward,leaving Dudleyville to the west; past Thurman, crossing the

railroad a little south of Welch station, and then on towards the Georgia line. An *anticline* may be traced approximately parallel with the line of the Western Railroad from Farrall's Mill, in S. 30, T. 18, R. 25, E., past Wright's Mill, Chewacla Lime Works, Springvalla and thence through S. 7, T. 20, R. 28, E., to the river near the upper factory below West Point. Hornblendic rocks prevail to the north-west and mica schists to the south-east of this anticlinal, and at many points the gradual passage from hornblendic gneisses to mica schists may be perceived. This gradation is usually effected by alternations of the hornblendic rocks with the mica schists in a narrow belt between the two well defined types, and may be observed in sections 6 and 7 of T. 20, R. 28 east, and also near the upper factory above mentioned. Along the river road between West Point and Columbus, another *synclinal*, may be observed, a little south of Osanippa (Berlin), and an *anticlinal* between Mechanicsville and Wacoochee, or rather at the latter place. These have not been accurately located further to the west for the reason that the superficial sands, pebbles and other materials of the Lafayette formation cover all the country in that direction, practically limiting obtervations of the underlying crystalline rocks to the drainage valleys, and to a very small part of them.

While the gneisses vary in structure from the granite-like masses to the highly fissile mica schists, they vary on the other hand in composition by the accession of hornblende, through hornblendic gneisses, often with difficulty to be distinguished from diorites, to hornblende schists. It is certain that variations also occur in the prevalence in different areas, of different kinds of mica and different kinds of feldspar, but we have had as yet too little of accurate study of these rocks to put us in position to speak very definitely on these points, except where we have had the microscopic examinations made, which are given in detail in another part of this report. Within the area of the hornblendic gneisses occur in places massive diorites, resembling granite in structure, and like them of intrusive origin. Under the next head are given some details of the occurrences of these diorites.

In surface distribution, the gneisses, including the hornblendic gneisses with which they so often alternate, occupy (1) a belt lying to the north-west of the Goldville belt of Talladega slates. This we may call the Alexander City gneiss belt, which is practically continuous from the Coosa River nearly to the Georgia line. It holds many areas of "flat rocks" or granites in Coosa county, but in Clay and Randolph counties these granites are generally in the form of isolated masses in the Talladega slates, usually, however, close to the borders of the gneisses.* Towards the north-west the gneiss of this belt passes into a mica schist which very often continues up to the great mountain-forming belt of the Talladega slates, though this is not invariably the case, as for instance near Arbacoochee, in Cleburne county, where the gneiss lies next to the Talladega slates, or with only a narrow belt of the Hillabee or Millerville green schists between. This gneiss belt does not appear to reach to the Georgia line; or if it does, it is in much diminished volume, for beyond Arbacoochee, Hightower, etc., in Cleburne county, the Talladega slates are seen in direct north-eastward continuation of the gneisses.

In this first or Alexander City gneiss belt, there are many occurrences of coarse pegmatitic granite in dikes or veins. These veins are the sources of mica and of kaolin, and are most numerous and promising perhaps in the vicinity of Micaville, Pinetucky and Milner, in Randolph county; but at many points in Cleburne, Clay, Coosa and Chilton, along this belt, the mica has been found in sheets of merchantable size, but in few, if any, of the localities of its occurrence has it been opened up to sufficient depth to be beyond the influence of the weather. Mr. Brewer has given localities and some details concerning these occurrences, and other details will be found in my report for 1874. In Randolph and also in Clay and Chilton, there are old pits where this mica has been worked in ancient times, for in these pits are now growing pine trees a foot or more in diameter. Near Hissop, in Coosa county, and at several points towards the south-west as far as Speed, this pegmatite carries beryls of quality suitable for cutting.

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*Some of these "granites" are merely massive forms of the gneiss, but in other cases they occur as "dikes."

(2)The second gneiss-mica schist belt separates the Goldville and Silver Hill slate belts. In Coosa and Tallapoosa counties this belt is tolerably uniform in quality and width, but in Randolph it seems to divide, with Talladega slates between the division, and to break up into somewhat isolated areas in the midst of the Talladega slates. Three of these detached areas may be named, each containing some granite, i. e., one about Gay P. O., another just south and south-west of Wedowee, and a third a little to the north and north-east of Wedowee, the three areas somewhat *en echelon*.

(3)The third gneiss belt includes, with the exception of the dolomite belt, Chewacla-Springvilla, above defined, the rest of our crystalline region towards the south-east. In this third belt there are the ordinary gneisses and granites, especially near the north-west border of the belt,but hornblendic gneisses and diorites prevail and give character to the topography, soils, etc. In this last section, so far as I am aware, there are no occurrences of gold, at least in notable quantity.

To the south-west of the Montgomery-West Point Railroad, much of the gneiss assumes the character of *augen-gneiss*, in which certain of the constituents, generally quartz or feldspar, appear in "augen" or "eyes."

i. e., somewhat elliptical shaped masses from one inch in diameter down. Several descriptions are given of this rock, as well as of the more common varieties, in the notes of Dr. Clements and Mr. Brooks below.

(2.) *The Diorites.*—After the gneisses and associated rocks, probably the most widely distributed of the rocks of this region are the diorites, which, as above stated, are often very difficult to distinguish from some of the hornblendic gneisses. The diorites occur as intrusive masses, often occupying long narrow strips in the direction of the strike, but sometimes as rather isolated masses of limited extent in the midst of the gneisses.

A belt of diorite (with hornblende schist in places) may be traced practically without interruption from near Verbena in Chilton county, through Coosa county past Hanover, Mount Olive and Pine Grove into Clay.

Somewhat in continuation of this line, but occurring more in detached masses we find this rock again in the lower part of Clay, while from about Chandler's Springs through Fishhead Valley, past Riddle's Bridge and thence north-eastward towards Wood's Copper Mine in Cleburne, there is another rather continuous outcrop like that of Coosa county.

To the south-eastward of the Silver Hill slate belt, hornblendic rocks are more generally present than in any other part of this section. Many of these are diorites, but the accurate mapping of these has not yet been attempted. The notes of Dr. Clements and Mr. Brooks describe a number of typical diorites from this area.

(3.) *The Hillabee, Ivana, or Millerville Green Schists.*—Along the south-eastern border of the main mountain belt of Talladega slates, there is an almost continuous outcrop of a green schists which microscopic examination discovers to be probably an altered eruptive rock. In the report of Mr. Brewer, which precedes, this is spoken of as the Millerville, Iwana, or Hillabee schist, using the names of localities where it shows in typical form. It may be followed practically without interruption, but with somewhat varying width of outcrop, from Chilton county through Coosa, where it underlies a tolerably wide expanse of country about Stewartsville and Iwana; thence through Clay, about Hollins, Pine Grove, Mountain Meadow, Brownsville, Millerville or Hillabee, Coleta, Chandler's Springs, Fishhead Valley; and on through Cleburne, by Chulafinnee, Arbacoochee, Anna Howe, etc. Beyond Chulafinnee the outcrop narrows down to a small strip. It is widest in Clay and Coosa where it underlies a sort of Flatwoods, as is the case near Chandler's Springs, Coleta, and Hollins, in Clay, and between Iwana and Stewartsville, in Coosa. In fresh condition these rocks are of light green color and are rather massive in structure, and very tough, but on weathering they turn into greenish yellow slates much stained with iron, and then bear a striking resemblance to some of the Talladega slates with which they are in immediate contact. The soil derived from the weathering of these schists is a yellowish or reddish clay with a notable proportion of lime, indicated by the character of the growth which contains a considerable admixture of haw, crab apple and similar lime-loving plants. The manner in which the soil compacts under the wheels of vehicles is also suggestive of lime. When partially decayed, these slates as above stated, have a strong resemblance to sedimentary rocks, and especially to some of the feebly crystalline slates of the Talladega series. This resemblance is particularly strong in the case of some of the more siliceous varieties which imitate very closely some of the conglomerates and siliceous slates of the Talladega. In some of their outcrops they resemble impure slaty limestone, as is the case just below Coleta, in Clay county. In other places of their occurrence they break up into long, slender and somewhat cylindrical fragments, exceedingly tough and resistant to weathering. The immediate vicinity of Chandler's Springs furnishes an illustration of this phase. The highly schistose and slaty varieties may be seen about Hillabee or Millerville, in Clay county, and particularly at Monroe's Mill close by. The varieties resembling siliceous conglomerate abound along the road leading from Millerville towards Hatchet Creek postoffice, and especially along the flanks of McGhee Mountain. In many places, and particularly where these rocks make a moderately wide belt of country, they form "Flatwoods," with decidedly calcareous soil, supporting a growth of short leaf pine and black jack oaks, with many haws, persimmons, poplars, crab apples and sweet gums interspersed. Such Flatwoods may be seen about Chandler's Springs and between the Springs and Coleta, also for a long distance along the road from Millerville westward towards Hatchet Creek, by Pine Grove and Hollins, and in great force near Iwana postoffice and on to Stewartsville. Below Stewartsville these flatwoods are succeeded by flat, long-leaf pine lands bearing some of the finest timber to be seen in middle Alabama. The siliceous rocks of the Talladega slate formation underlie a great part if not all of these pine lands.

In places the Hillabee schists hold a large percentage of pyrite in crystals disseminated through a siliceous rock. When the proportion of pyrite crystals is large it seems probable that the mineral might be concentrated without too much expense, so as to make it profitable to mine. In most of the cases which I have observed, the rock has a large percentage of quartz grains along with the pyrite. Attempts have been made at several points to mine this pyrite, especially in the vicinity of Hatchet Creek P. O. in Clay county, where it is relatively abundant. A large quantity of it was thrown out of the old

McGhee copper mine many years ago. At C. C. Duke's in S. 17, T, 23, R. 17 in Coosa county, some work has been done towards exposing the vein or seam which bears the pyrite.

Also in section 24, T. 19, R. 7 E., in Clay county, and at the old Montgomery Copper Mine close by, there is a very good show of pyrite. In S. 24 the seam is four to five feet in thickness, while at the Copper Mine it may be greater, for about the mouth of the old shaft there are masses of the pyrite of considerable size. It was impossible for me to see there any exposure of the vein or seam because of the falling in of the old works. In these cases, as in the lower part of Clay and in Coosa, the pyrites is mixed with quartz grains.

Microscopic examination of thin sections of these rocks shows that they are composed of actinolite, epidote, chlorite and zoisite in the main, with some quartz, and they have been named by Dr. Clements and Mr. Brooks Chlorite-epidote schists, Actinolite-epidote schists, Chlorite schists, etc., according to the prevailing ingredient.* In general, the alteration has gone on to such a degree that the determination of the original rock from which they have been derived is difficult, but all agree in thinking that they are result of alteration of some basic eruptive rock. For the present, therefore, we have grouped them together under the name *Hillabee*, from the locality where they are exposed in typical fashion. Some of the gold occurrences in the north-western belt seem to be closely connected with these rocks, as at Chulafinnee, Anna Howe, etc.

(4.) *Other Basic Rocks.*—At many points within the gneiss belt occur dikes and isolated masses of pyroxenic, chrysolitic and other basic rocks. These are mostly so much altered at the surface as to make it often very difficult to determine what was the original rock, for at the outcrop they appear in the form of chlorite, steatite, serpentine, etc. These occurrences have not been mapped as yet, and I shall call attention only to some of the best known. The notes of Dr. Clements and Mr. Brooks give many interesting details concerning them. In the great gneiss belt lying furthest to the north-west occurrences of these rocks are to be seen at several points; to the north of Goodwater; in a number of places near Flatrock post office, and in Fishhead Valley in Clay. In the next gneiss belt, these rocks occur at several places near the north-western border of the gneiss, e. g., at Robert Goodman's in S. 36, T. 22, R. 2, at Fosheeton and one or two points further north-east in the same line. Then along the north-western border of the Dadeville gneiss belt near its contact with the Silver Hill gold belt, e. g., in R. R. cut just below Dadeville; on Sandy Creek south of Dadeville; seven miles north of Dadeville, and thence in a north-easterly direction by Easton P. O. near Dudleyville; on towards Bosworth, near Slay's Mill in Chambers county. This seems to be a rather connected line of these rocks. At two places there is associated with these rocks along with steatite, chlorite, asbestos, etc., a notable quantity of corundum, occurring in detached masses. These two localities are Robert Goodman's, below Alexander City, and the vicinity of Dudleyville.

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*See Nos. 38, 39, 40, 4 of Dr. Clements, and Nos. 4, 5, 6 and probably 9 of Mr. Brooks.

Near the Tallapoosa river, a few miles above Tallassee, there is a considerable mass of steatite which has been used by the Indian in the manufacture of pots and vessels of different sorts, the remains or fragments of which are abundant in the vicinity. Another similar locality is in section 35 or 26 of T. 20, R. 23, which may indeed be only another appearance of the same mass of rock. Here are also many fragments of the vessels formed from the soapstone. Of other soapstone localities I may mention the vicinity of Oak Bowery, and S. 8, T. 21, R. 28 in Chambers. In a number of places, in Chambers county particularly, there is a variety of actinolite rock, often containing a good deal of steatite, and this is very generally known as soapstone. It has been quarried at a number of points and used for slabs over graves, for lining the Chewacla lime kilns, etc. One such locality is near Oak Bowery, on the place of Mr. W. P. Spradling, S. 34, T. 21, R. 26. Another is west of Milltown, formerly worked by Mr. Jackson,another at Five Points, worked now by Mr. Jackson's son.

In the upper north-western part of the Crystalline Schists the occurrences of dikes of the basic rocks are not so numerous, though not wanting, as has been shown above. Soapstone has been observed near Idaho Post-office, and at the Old Wood's Copper Mine in Cleburne; and at some other localities, and chlorite schists may be seen near Copper Mine P. O. in Clay, and in Fishhead Valley. The Hillabee Schists are generally considered as having been derived from some form or forms of basic igneous rock, not now determinable because of the alterations which they have undergone.

Mode of Occurrence of the Gold.

From Mr. Brewer's report and from that of Dr. Phillips, it will be seen that a large proportion of the gold-bearing quartz veins are associated with the semi-crystalline slates of the Talladega series, which are of sedimentary origin. These slates have in the past usually been referred to as talcose slates, and hydromica slates. Perhaps the term *talcoid* might be used with propriety, since they have the general look of talcose slates with, however, very little if any magnesia in their compositon. The gold of the Silver Hill belt, of the Goldville, Hog Mountain belt, of the Turkey Heaven Mountains, and of the Talladega Mountain belt occurs in slates of this kind. In many instances intrusive masses of granite or of diorite appear in close proximity to the gold bearing slates. As an instance of this the Crooked Creek, Goldberg region, may be cited.

A second mode of occurrence of the gold is in association with gneiss, hornblendic gneiss, and diorites, as illustrated in the belt including Pinetucky, Franklin Mines, etc. A third association is with the green schists of the Hillabee type, as at Arbacoochee, Anna Howe, etc. . At Arbacoochee, the gold occurs at the junction of these green schists with gneiss, so that the association might be considered with either.

The gold bearing quartz veins are in the great majority of cases what have usually been termed bedded veins or veins of segregation. They are so termed in the report of Mr. Brewer. Prof. G. F. Becker, of the U. S. Geological Survey, has recently made an examination of the gold fields of the Southern Appalachian as far south as Georgia, and while his examinations did not extend actually into Alabama, his descriptions apply with almost equal force to the Alabama fields. In the other states to the north-west of us, however, there seems to be a much larger proportion of the gold associated with the igneous rocks or with the schists derived from them than is the case in Alabama.

Since the report of Mr. Becker upon the Gold Fields of the Southern Appalachians* embodies modern views upon the structure of the rocks, the character of the veins, etc., I have thought it desirable to give below an abstract of some of his conclusions, which appear to me to be possibly applicable to our Alabama measures.

Structure of the Associated Rocks.

In Alabama, as well as in the south-eastern states, the structure of almost the entire mass of the older rocks is schistose, the strike of the planes of cleavage being generally that of the Appalachian range, or N. 30 deg. to 50 deg. E. Where sedimentary strata occur they too strike in approximately this direction, in consequence of the folding which has built up the range; and as a consequence of this fact, the cleavage of the schists has very often been mistaken for bedding. The dip of these schists is generally towards the south-east, though occasionally, north-west, as well as other abnormal dips, occur. These remarks apply to the more prominent surfaces of schistose cleavage, but observation will generally show that there are schistose partings at a large angle to the most pronounced one, and when the two are about equally developed, their intersection being nearly horizontal, the strikes of each are approximately the same. Occasionally there are other schistose cleavages striking nearly at right angles with the predominant cleavage, but these play a comparatively unimportant part. According to modern views, massive igneous rocks such as granite, as well as stratified rocks, are converted into schists by the development of planes of cleavage by shearing, i. e., "by the sliding of each of the parallel infinitely thin lamellæ, of which the rock may be considered to be made up, upon that next below it, in the same direction and by the same infinitesimal amount," the movement being distributed over an infinite number of surfaces and not reaching the rupturing strain on any one. If the rock is not very uniform in composition, some portions of it may acquire the schistose structure before others, and the resulting schist will show bands or sheets in which different degrees of schistosity will be exhibited. If the deforming movement be carried far enough, fissures will be opened in part of the schist and carunculated surfaces or puckered surfaces will result, whilst other portions of the schist will have merely flat cleavage surfaces. It is in such unevenly deformed rocks that fissures have opened most widely and veins are most abundant and widest. "Caruncalated surfaces are therefore properly regarded as favorable indications by the miners."

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*Sixteenth Annual Report of the Director of the U. S. Geological Survey.

Prof. Becker finds proof that the opening of the fissures now filled with ore took place later than the movements which rendered the country schistose, in the fact, among other things, that angular fragments of schist are often enclosed in the quartz ; on the other hand the connection of the ore deposits with dikes does not appear to be very close, but coeval on structural grounds, since neither the ore deposits nor the dikes have been greatly disturbed since their formation. The observations of Prof. Becker show that in the great majority of cases the fissures follow the schistose partings somewhat closely though not accurately, showing a certain degree of correspondence between the producing forces of two. Nevertheless the movements were not in general identical in direction. This is shown first in the existence of veins and fissures at various angles to the schistose surfaces, and secondly, in the circumstance that some of the markings produced in the dislocations accompanying the opening of the fissures, do not coincide in direction with the motion which produced the schistosity. Again, where the rocks are schistose and the main ore bodies are intercalated, stringers almost always cut into the walls. From the relation of these stringers to the planes of cleavage of the schists it is inferred with a reasonable degree of certainty that the opening of the fissures has been accomplished by *normal* faulting, while the cleavage of the schists has been the result of *overthrust* or *reverse* faulting; in other words, the movements producing the schistosity and those producing the fissures have been in opposite direction though approximately along the same planes

The Veins.

As has already been said, the ore deposits of Alabama show approximate conformity with the structure of the wall rocks, and for this reason have often been described as bedded veins, and veins of segregation.

As shown by Prof. Becker, the structure with which the deposits are approximately conformable is not stratification, but schistose cleavage, which he also shows to have been produced prior to the movements which opened the fissures, and further, the pressures which opened the vein fissures did not in general coincide in direction with those which had previously produced schistosity. The result of the dislocation was to produce lens-like openings along the main cleavage of the rocks, which were subsequently filled with quartz, forming what he terms lenticular stringers. These stringers are often discontinuous, one dwindling away or disappearing while its place is taken by another in the foot or hanging wall. In many instances diagonal seams may be seen to connect such imbricating stringers, and where the connection cannot actually be seen it is nevertheless inferred to exist, and the conclusion is reached that all the stringers were once united by cracks sufficiently large to permit the passage of solutions. Such connected groups of veins have been termed by Prof. Becker "linked veins," and the association of small fissures, each bearing a lenticular mass of quartz, he calls a *stringer lead*.

While the greater part of our Alabama Gold deposits correspond to the stringer lead type, yet there are numerous small cross fissures. Instances of this are given by Mr. Brewer, for example in describing the occurrences about Goldberg, on Crooked Creek. From what has been said, it will be seen that the stringer leads, while coinciding in general with the schistose structure of the country, do not coincide with it in detail, and that they are of the nature of true veins, i. e., filling of preexisting cavities. Instances are also numerous where the veins are attended by impregnations of the country rock to such a degree that it is mined and milled along with the material of the veins themselves.

As stated above, the connection of the ore deposits in Alabama with the dikes cannot be clearly made out, nor can it be said that a satisfactory explanation of the origin of the gold has been reached.

The Placers.

The loose materials carrying the gold in the Southern Appalachians is, according to Prof. Becker, of two kinds, viz., the ordinary stream gravels, and the accumulations of rotten rock in place. To this latter, he proposes to give the name of *saprolite*, as a general term for thoroughly decomposed, earthy, but untransported rock. The celebrated Arbacoochee placers illustrate this term very perfectly.

Mr. Brewer's report above gives full details of the placers which have been worked in Alabama, and nothing further concerning them seems called for here.

B. NOTES ON THE MICROSCOPIC CHARACTERS OF THE ALABAMA CRYSTALLINE OR METAMORPHIC ROCKS.

1. *Notes by Dr. G. W. Hawes.*

The first attempt to study the rocks of Alabama by means of the microscope was made by Prof. Geo. W. Hawes, then of New Haven, Conn., who prepared and described for the geological survey about 25 thin sections of crystalline rocks, sent to him by myself in 1875. I give below a list of the indentifications made by him.

No. 1. Hornblendic mica-schist, Columbus, Ga. (Quartz, orthoclase, hornblende, and biotite.)

No. 2. Graphitic mica-schist, Coosa county. (Quartz, muscovite, and graphite.)

No. 3. Garnetiferous mica-schist, Randolph county. (Quartz, muscovite, biotite, apatite, garnet.)

No. 11. Epidote schist, Clay county. (Epidote, mica, quartz, hornblende.)

No. 13. Hornblende schist, Chilton county. (Hornblende, quartz, orthoclase, oligoclase, ilmenite.)

No. 15. Hornblendyte, Tallapoosa county. (Hornblende, oligoclase, quartz.)

No. 17. Andalusite in hornblendite, Clay county.

No. 17a. Epidosite, Clay county. (Epidote, cyanite, staurolite.)

No. 18. Hornblendyte, Dudleyville, Tallapoosa county. (Hornblende, chlorite, epidote.)

No. 19. Graphitic quartzite, Coosa connty. (Quartz, graphite.)

No. 20. Diorite, Chilton county. (Hornblende, labradorite, titanic, iron, pyrite.)

No. 21. Dolerite, near Auburn, Lee county. (Pyroxene, labradorite, magnetite.)

No. 22. Ossipyte, near Ragan's Mill, Notasulga, Lee county. (Labradorite, chrysolite, hypersthene, titanic iron.)

No. 23. Dolerite, Oak Bowery, Chambers county. (Pyroxene, labradorite, magnetite.)

No. 24. Granulite, Coosa county. (Quartz, feldspar, garnet, epidote.)

No. 25. Hornblendite, Wood's Copper Mine, Cleburne county. (Hornblende, quartz, feldspar.)

During the winter of 1892, Dr. J. Morgan Clements, at that time assistant geologist of the Alabama Survey, made a trip through the territory of our crystalline rocks with the purpose of collecting for microscopic examination typical specimens of the rock varieties most common in that section. The results of his work are given below. Other specimens collected by me were sent to him for identification and study later, in 1894 and 1895, and his report on these follows the article just referred to.

During the summer of 1895, at the request of Mr. C. W. Hayes, of the U. S. Geological Survey, I made a small collection of the crystalline rocks which have been examined by Mr. Alfred Brooks, of the U. S. Geological Survey, whose report appears below. Besides these examinations, Mr. Harry D. Campbell, of Lexington, Va., and Prof. Van Hise, of Madison, Wis., were kind enough to identify for me a number of crystalline rocks, about which there was uncertainty as regarded their origin.

It is the intention to continue these studies of our crystalline rocks, and to publish the result from time to time.

To the notes of Dr. Clements and Mr. Brooks I have added in foot notes such comments as to the associations and distribution of the several varieties described, as have seemed desirable.

2. NOTES ON THE MICROSCOPICAL CHARACTER OF CERTAIN ROCKS FROM NORTH-EAST ALABAMA.

BY

J. MORGAN CLEMENTS.

MADISON, WIS., Dec. 18, 1895.

Dr. E. A. Smith,
State Geologist, Tuscaloosa, Ala.

DEAR SIR :—I send you herewith a brief description of the rocks collected by me during the ten days spent in December, 1892, in the crystalline area of Alabama.

Immediately upon returning from the reconnoissance chips were sent away to be sectioned, but owing to unavoidable delays the sections were not received until nearly six months thereafter. My acceptance of a position elsewhere and entrance upon my new duties almost immediately prevented my completing the work begun on the Alabama Survey.

It has been a source of much regret that other duties have prevented me from sending you ere this the description of the rocks which through your kindness I was enabled to collect.

Very respectfully,
J. MORGAN CLEMENTS.

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INTRODUCTION.

The rocks examined were collected by me for the Alabama State Survey during ten days spent on a reconnoissance trip in the north-eastern part of the State. It was primarily my object to visit and collect specimens for study from certain igneous rocks observed by Tuomey[*] E. A. Smith,[†] and C. H. Hitchcock,[‡] and in general to collect specimens of the various crystalline rocks met with, in order that, from a study of the sections, I would be better prepared to undertake the mapping of the area which was contemplated as the work for the following season. The following is really a brief account of the journey, embodying all observations made, with the addition, however, of the notes on the microscopical characters of the rocks collected.

At the end, under the head of conclusions, I have arranged the rocks according to their probable origin, since, in view of the investigation now in progress in the crystalline area, the origin of its rocks is of great importance as indicating the relations to the overlying sedimentaries. It is this line of microscopical inquiry in conjunction with stratigraphical work which will probably be most fruitful in determining whether or not there is an Algonkian series of sediments—more or less metamorphosed—present in Alabama, or whether all the crystalline rocks are to be grouped with the Archæan.

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[*] Second Biennial report of the State Geologist of Alabama. pp. 51, 61, 63, 1858.

[†] Observations of Profs. Smith and Hitchcock may be found in their manuscript notes.

[‡] A hand specimen of the rock mentioned by Prof. Tuomey on p. 51 of his second report, was found in the University collection with his label attached. This was submitted to Prof. Hawes, and by him described as *Ossipyte*: see his No. 22 above. Neither Prof. Hitchcock, Dr. Clements nor myself has succeeded in finding this rock in place.
E. A. S.

Many of the rocks have been affected to a considerable depth by the atmospheric agencies. Frequently they will retain their structure quite perfectly, but when one attempts to collect a specimen the mass crumbles in the grasp. When the rocks have been subjected to active erosion and this thick weathered portion has been removed they will be found to be covered only by a thin altered layer and to compare in freshness with similar rocks from other regions.

An attempt was made to locate all ledges from which specimens was taken, by the sections, townships and ranges, but this proved a failure. In most cases the farmers do not know, or at least were very uncertain as to the section and portion of the section in which they were located.

Notasulga to Ragan's Mill.

Notasulga, where the first stop was made, is built on the light colored sand and gravel of the Lafayette formation, which covers the most of the Coastal Plain of the Southern States. For a mile north of this point the road to Ragan's Mill, Sec. 32, T. 19 N. Range 24 E., passes over this light colored soil. The change is then noticed to the red clayey soil of the crystalline schist area. About ½ mile before reaching the mill, we pass over very rotten mica schist striking N. E. and S. W. and dipping about 45 deg. N. W. Just before reaching the old mill-race, rotten mica schists outcrop again, and have interbedded with them a bed of quite fresh dark green, rather coarse grained schist, Sp. 1, 8 inches thick, striking N. E. S. W. and dipping to the N. W.

Sp. 1. *Amphibolite.*—The hand-specimen shows a vein of quartz which is parallel to the schistosity. Under the microscope the rock is seen to be composed of common green hornblende in interlocking prisms, with a very small amount of quartz, in grains, associated with it. The hornblende shows marked pleochroism, with the usual absorption, *a.* yellow, *b.* yellowish green, *c.* bluish green, where $c > b > a$. It includes only a few round blebs of quartz. The prisms of hornblende lie with their longer axes in the same general direction, giving a marked schistosity to the rock. There is nothing which gives any clue at all to the origin of the rock.

Several bands of garnetiferous mica-schist are exposed in the banks of the mill-race. The bands strike S. E.-N. W. and dip to the N. W. Numerous small pegmatitic dikes were seen cutting these schists and intersecting each other. One dike of granite, 1½ feet wide, has forced its way in between the strata. Immediately under the bridge the strata are contorted at a point where this granite intrusion shows marked increase in thickness.

Across the race, in the stable yard of Mr. Jones, the schists have a strike N. E.-S. W., with a dip to the N. W., the amount, however, not being determinable, as it was only a surface outcrop. These schists form the knoll upon which the house is built. The schists are here cut by a granite dike, Sp. 32. The rock is light, nearly white, and quite fine grained.

Sp. 2. *Biotite Granite.*—The microscope shows a rock with typical granitic structure and consisting of quartz, microcline and an unstriated feldspar which is presumed to be orthoclase, plagioclase, and biotite as essential constituents, with apatite, garnet, zircon, and rutile present as accessory minerals. As secondary minerals we find epidote and muscovite. The quartz is the ordinary granitic kind, containing both gas and fluid inclusion, the latter frequently with a dancing bubble. Long needles of rutile are rather common in it and zircon is also found enclosed by it. Microcline, which forms the greater part of the rock, is also present in xenomorphic grains and encloses blebs of quartz. It shows the characteristic cross-hatched structure and commonly contains the spindle-shaped microperthitic intergrowths of a triclinic feldspar. Very little orthoclase is present in unstriated grains. Its place seems to have been taken by the microcline. The orthoclase encloses rutile and apatite. Plagioclase is also rather rare in partly automorphic crystals polysynthetically twinned according to the albite law. Biotite is found in fairly well developed crystals whose contours are, however, at times indented by the other minerals, and whose edges are in places quite ragged. The pleochroism is strong, sections cut parallel to the *c* axis varying from brownish yellow to dark, almost opaque brown. It is beginning to alter on the edges to muscovite. No magnetite was observed in this section. Apatite is in small crystals and is not common. Zircon is rather rare. Rutile occurs in fine needles in the quartz and orthoclase. A light pink garnet without crystal faces was also found in the section. A few garnets are also to be seen macroscopically in the hand specimen. Slightly pleochroic epidote was observed in imperfectly automorphic crystals, usually associated with biotite. All of the minerals are quite fresh, no traces of alteration being observed except in the biotite, which alters to muscovite, and a cloudiness along the edges of the feldspar grains and in cracks traversing them. The order of crystallization is first the accessory minerals, then biotite, plagioclase, microcline, and quartz. The granite shows evidences of dynamic action to a slight degree in the undulatory extinction observed in certain of the quartz grains and in the bending of the twinning lamellæ in some of the feldspars.

Beyond Mr. Jones' house, just before crossing the Sougahatchee Creek, we pass an exposure of rotten micaceous schist with the usual N. E. and S. W. strike and N. W. dip. A somewhat schistose granite rock, Sp. 3 and 4, is seen to form the hill across the creek.

Sp. 3. *Biotite Granite.*—This is macroscopically a light colored, slightly greyish, medium grained rock, showing a banding caused by alternating layers of rock material which are richer and poorer in dark mica.

Under the microscope the rock is seen to be composed of essentially the same minerals as the granite, Sp. 2 above described. Moreover the structure is the same except that a scarcely noticeable parallel arrangement of the mica plates exists, and a general agreement in the long extension of the grains of feldspar and quartz can be seen. In Sp. 3 the mica, which is the same dark brown biotite found in the granite, is in parallel intergrowth in places with a light colored mica muscovite, with strong absorption of the rays vibrating parallel to the cleavage. Neither the accessory rutile needles nor the garnet or epidote is present in the section. The feldspar begins to show alteration, with accompanying production of muscovite. The specimen also shows slight pressure phenomena.

Sp. 4. *Biotite Granite.*—This was collected by Prof. Hitchcock from the same locality, and is identical in every respect with Sp. 3.

I have called this rock a granite in spite of its slightly banded character. It might perhaps be more correctly called a gneissoid granite, for the succession of crystallization of these minerals and the microscopical character show it to be an eruptive rock. The question then arises as to the origin of the laminated structure in it which causes it to simulate a gneiss. The structure is original, for the dynamic action which the rock has undergone is very slight, as shown by the lack of a well developed cataclase structure. It seems reasonable to explain the lamination as the result of differential movement in the original rock magma. The great resemblance between Sp. 3 and 4 and Sp. 2 and their close proximity to each other leads me to suppose, although no connection between them was observed, that they are portions of the same rock mass. Upon closer study of the occurrence it will probably be found that the mass from which Sp. 3 and 4 were taken is either a great dike, or else a laccolitic mass from which the smaller dikes cutting the schist, such as the one from which Sp. 2 came, were sent out.

According to Tuomey there occurs at Ragan's Mill a dike of gabbro. (2nd Biennial Rep. State Geologist of Ala., 1858, p. 51). This dike was sought for by Hitchcock, but like myself he failed to find it. Hitchcock found, however, near the grist mill what he describes as a very modern looking basaltic rock. (Manuscript notes). At first sight the rock collected by Hitchcock also impressed me as resembling very closely certain young volcanic rocks. As it would be exceedingly interesting if such a rock could be found *in situ* occurring in the Appalachians, an especial search was instituted for it near the site of the mill, for the mill itself no longer exists, but failed to bring it to light. Under the microscope the rock is seen to be a basalt of exactly the same type as that quarried at Niedermendig, Rhenish Prussia, and exported extensively for use in America and elsewhere for millstones, and this was the rock to which it was referred when first seen. Without being able to state positively, it seems to me that the specimens collected by Prof. Hitchcock owe their origin to such an imported millstone, it probably having been broken up into fragments, so that he was not able to observe traces of workmanship upon it.*

The following is a brief description of the rock collected by Hitchcock:

Sp. 5. *Leucite Tephrite.*—This is a fine grained gray vesicular rock. Under the microscope its constituent minerals are seen to be augite, olivine (?), biotite, leucite, apatite, and magnetite. Augite occurs in porphyritic minerals and also in very small grains in the groundmass, that is in two generations. In color it is yellow, with a very faint pleochroism. At times it is zonally arranged, with a green pleochroic aegirine-like pyroxene at the center and around it a zone of ordinary augite. It shows the ordinary characters, so frequently described, of basaltic augite. Biotite was present also in porphyritic crystals. Its former presence is determined by its form. Certain paramorphs after it, which retain the biotite form, now are made up of grains of augite and magnetite, the biotite substance having been completely resorbed by the magma. The augite and biotite crystals lie in a fine grained groundmass which consists chiefly of small augite crystals and magnetite, with leucite and plagioclase as feldspathic elements. The leucite shows no optical anomalies in the small crystals here present, but is isotropic. Its outline is marked by the characteristic zonal inclusions of augite, magnetite, and brownish glass. The plagioclase is in small polysynthetically twinned lath-shaped crystals. The magnetite forms well developed crystals of small size. Apatite is present in needles, and in one case a fairly large crystal which was quite full of black interpositions. Numerous grains in the groundmass which are colored yellowish brown by iron hydroxide may be slightly altered olivine, but I could not be sure that they were. Nepheline was sought for in the groundmass but was not found with the microscope, and no microchemical tests were made to prove its presence. Glass was likewise not found, although it is probably present as colorless films between elements forming the groundmass.

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*In the summer of 1895. I collected specimens of this rock from the old mill race, and obtained positive proof that it formed part of a millstone imported many years ago by Mr. Ragan. Dr. Clements' conjecture as to its origin is thus verified. E. A. S.

Notasulga to Wood's Mill.

A short visit was made to a small quarry to the north-west of Notasulga, which can be found on the right-hand side of the road about 350 paces in the woods, ¾ mile before reaching Wood's mill. The quarry is abandoned and pretty nearly full of water.

Sp. 6. *Biotite Granite.*—Microscopically the rock is medium grained, gray, and does not show in the hand specimen a gneissoid structure. This is only seen in the rock *en masse* in the quarry, the banding striking N. E. S. W. and dipping 5 deg. S. W. There is a parting which runs parallel with the bands and separates the rock into massive layers. This parting greatly facilitates quarrying.

Under the microscope it is found to be composed of quartz, microcline, orthoclase, plagioclase, biotite, muscovite, and very little magnetite. Apatite and zircon are present as accessory minerals. These minerals all possess the usual characters as described above. The mica is the ordinary brown biotite, showing the absorption, and also muscovite. This latter is frequently seen in parallel intergrowth with the biotite. There is an easily recognizable absorption in it of the rays vibrating parallel to the cleavage, giving it a faint greenish tinge. Some of the minerals show traces of beginning alteration. In the feldspar this slight cloudiness is the beginning of kaolinization. Some calcite, probably infiltrated, was also observed in the section. Undulatory extinction was rare. The rock bears great resemblance microscopically to Sp. 3 and 4 from Ragan's Mill, and it is highly probable that it belongs to the same rock mass.*

Auburn to Mr. Drake's.

One mile north-west of Auburn, in Sec. 19, T. 19 N.,

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*To this same rock mass belongs also very probably, the granite described by Mr. Brooks below from 3 miles west of Loachapoka.

E. A. S.

R. 26 E., near Mr, Drake's farm, a quarry in gneiss was visited. The schistosity strikes north-east and south-west and dips 20 deg. south-east.

Sp. 7. *Biotite Gneiss*.—A fine grained dark gray schistose rock very rich in biotite. The microscope shows quartz, plagioclase, orthoclase, biotite, muscovite, and magnetite to be the chief constituents. As accessory minerals garnet, zircon and thulite were observed. The minerals quartz, feldspar and mica are in grains and ragged fragments, and consequently show no well defined order of crystallization. The mica lies between other minerals with well marked parallelism of the long extension of its plates, and gives the rock its schistose structure. Zircon is included in the biotite, and the biotite immediately surrounding it has a very much stronger absorption than elsewhere. A few small crystals of rose-colored manganiferous zoisite—thulite—were found. One was seen included in biotite, and like the zircon surrounded by a pleochroic court. The remaining minerals present their ordinary characters. The rock is quite fresh, slight kaolinization of the feldspar being the only alternation which is shown. It has, however, undergone considerable crushing, to judge from the bending of the mica and undulatory extinction in the minerals. This has even gone far enough to produce an imperfect cataclistic structure. Nothing could be seen indicating the mode of origin of the gneiss, though the crushing might lead one to suppose that it was a metamorphosed eruptive, perhaps originally a biotite granite.

Auburn to Wright's Mill.

A search was made along the road running towards Wright's Mill, south-east of Auburn, for a dike of diabase observed by Dr. Smith, and found about three miles from metamorphic action from an original biotite granite. Macroscopically it is a typical "augen" biotite gneiss, with a well marked oval augen around which the mica layers bend.

Under the microscope the eyes are composed of feldspar, both polysynthetically twinned and an unstriated kind, quartz, and biotite. The association is granitic, the biotite and triclinic feldspar showing the best development. All the minerals are very fresh. The feldspar is full of minute automorphic crystals of epidote, and zoisite, and contains also small plates of muscovite. The feldspar substance between these minerals is perfectly fresh, showing no trace whatever of alteration. The feldspar shows only slight undulatory extinction. The quartz between the feldspar is, however, already crushed, and is present as an interlocking mosaic. Surrounding the eye there is a zone of varying width composed essentially of minute brown biotite scales with a few larger biotite and muscovite plates lying in a mosaic of crushed quartz and feldspar. Imbedded in the mica are large sphene and epidote crystals. In one case a brown allanite crystal was observed surrounded by epidote, as described by Lacroix* from several localities, and by Hobbs† from the Ilchester granites of Maryland. The sphene and epidote crystals lie with their long extension parallel to the schistosity of the rock. Also a little pink garnet was seen. These and the mica are evidently secondary. They show no sign of crushing. In this biotitic portion there are also minute eyes formed of single oval feldspar crystals surrounded by a mosaic of small grains of feldspar ground from the large crystals by crushing. The quartz seems in all cases to have been ground down to what we may call a miscrocopical powder, so fine are the grains at times, and this forms the most of the material in which the biotite flakes lie. The specimen shows the phenomena accompanying crushing and shearing most beautifully. The crushing of the quartz is especially well shown. From a large grain showing undulatory extinction the process can be traced to the next stage, where the grain is separated along lines perpendicular to the direction of schistosity. These various edges and also the ends around the outer edges and corners are then rubbed to a finely powdered mosaic of quartz, and in the last stage we have none of the original quartz left in large grains. The feldspar likewise is crushed, but it is usually first rounded by the grinding down of the corners, reducing it to a more or less oval outline. It is also frequently pulled apart and the cracks, extending perpendicular to the direction of movement, have been filled with quartz. Judging from the eyes, which apparently represent the original rock, this biotite gneiss seems to have resulted from the intense crushing of a biotite granite.

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*Contributions a l'étude des gneiss a pyroxene et des roches a wernerite. Bull. de la Soc. francaise de Mineralogie, tome XII, No. 4, April, 1889.

†On the Paragenesis of Allanite and Epidote as Rock-forming Minerals, by Wm. H. Hobbs. Johns Hopkins Univ. Circulars, No. 65, April, 1888; Am. Journ. Sci., Vol. 38, Sept., 1889, pp. 223-228; Tch. Min. Pet. Mit., Vol. 11, 1889, p. 1.

Sp. 11. *Biotite-gneiss.* This is a very much altered phase of the above. In it muscovite forms the greater part of the rock, and there is a great deal of ilmenite in well developed hexagonal plates. No epidote and very little sphene is present.

Sp. 12. *Biotite-gneiss.* This is a somewhat finer grained modification of Sp. 10. Instead of epidote we have, however, the rose colored manganiferous zoisite—thulite—appearing in rounded prismatic crystals. It is always surrounded by a narrow zone of clear white zoisite. The minerals have not in all cases exactly the same orientation, the extinction varying very slightly in the two zones. The thulite has even a lower polarization color than the zoisite, appearing almost isotropic. The occurrence of thulite in biotite-gneiss, noted also in Sp. 7, has, as far as I know, not been mentioned before. Its zonal structure with zoisite is especially interesting. The manganese present in the rock having been used up, the mineral continued to grow by the addition of the zoisite molecule. This zonal structure of the zoisite and thulite may be compared to that described by Lacroix and Hobbs[*] in the case of allanite and epidote intergrowths. Apatite is present in a few crystals.

Sp. 13. *Biotite-gneiss*, does not differ from No. 12 except in that it is a trifle finer grained and contains rather more muscovite.[†]

Below the mill there are outcrops in the creek under the bridge and along the road beyond the bridge of a pinkish quartz-schist. I was not sure of the true bedding.

Sp. 14. *Quartz-schist*.—This quartz-schist is almost exactly like Sp. 9, showing, however, a greater degree of alteration. The muscovite is not in such large flakes as in the last specimen, and in general the rock is somewhat coarser grained.

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[*] l. c.

[†] The augen-gneiss (biotite-gneiss) here desribed, numbers 10, 11, 12, and 13, occupies a belt four or five miles in width, that may be followed from the vicinity of Auburn northeastward to the Chattahoochee river, where its northern boundary is a little north of Mechanicsville, and its southern limit to the south of Wacoochee creek. In all this belt the several phases in the atmospheric decay of rock may be followed out.

In one stage the result of the alteration resembles very strongly a talcoid mica schist, such as is mentioned by Dr. Clements; this in turn passes into a purple or reddish clays somewhat like the clays characteristic of the Tuscaloosa formation of the Cretaceous.

The dolomite and quartzites of the Chewacla belt occupy a place in the midst of these gneisses, the dip of the gneiss being in both directions from the dolomite belt as though it were upon an anticlinal fold.

Mr. Brooks has also described specimens of the same rock from the same locality. Nos. 15 and 16. E. A. S.

Lafayette to Oakbowery.

Near Mr. Bledsoe's, Sec. 35, T. 22 N., R. 26 E., S. W. of Lafayette on the road to Oakbowery, a mass of rock is exposed striking across the road.

Sp. 15. *Diorite.*—This rock is dark gray, coarse grained, and imperfectly schistose. The minerals forming it are common green hornblende, pyroxene, feldspar, sphene, epidote, and magnetite. These show the usual characters of such minerals. The amphibole is perfectly compact and occurs in grains rather than in crystals. It shows a strong pleochroism, *c.* deep blue green, *b.* yellowish green, *a.* yellow. The pyroxene is a green malacolitic pyroxene, with scarcely noticeable pleochroism from light green to a slightly yellowish tinge of green. It is not present in any better developed forms than the amphibole. It is found in parallel intergrowths with, and also included in, the hornblende. Along the edges it is in places seen to be slightly fibrous, but no other trace of alteration was observed. Careful search was made for evidence of the secondary nature of the hornblende, that is, that it was the result of the alteration of a pyroxene, as has been so frequently described. Its relations to the green pyroxene, including it, seem to favor the idea of its formation from it, the included pyroxene grain representing an unaltered core. No proof of this could be found. The almost perfect freshness of the minerals is itself against it. I could only come to the conclusion that the amphibole and pyroxene are both original.

Both plagioclase and orthoclase are present, the former predominating. Neither possesses crystal outlines, though the plagioclase approaches automorphism most closely. Quartz is present in very small quantity in xenomorphic grains. Sphene is present in numerous small rhombs included in all of the other minerals. Magnetite occurs in a few rare grains. The extinction in all of the minerals is sharp; indicating a total absence of dynamic action. The epidote is of quite a different character from what has usually been observed. It is not found in crystals, but as a fringe or zone between the feldspar and hornblende. This fringe is not composed, however, solely of epidote, as is the case in the zone described by Williams,[*] but of epidote micropegmatitically intergrown with a clear white mineral of rather low single and double refraction. This mineral penetrates the epidote in curving rods, which branch, giving V shaped forms, and have in cross section rounded or irregularly long oval outlines. By changing the focus of the instrument the rods can be followed as they curve and run out without any break to join the feldspar, to which they evidently belong, since they extinguish with the feldspar. The feldspar forms perhaps one-third of the entire mass of the fringe. The epidote has in hand specimen a green color, and under the microscope a greenish yellow tinge without marked pleochroism. It has the high single and double refraction and rough surface of epidote, but no crystal outline. In no case could a figure be obtained in convergent light, probably owing to interference of the intergrown feldspar. No cleavage was observed. In fact, while the statement has been made that the mineral is epidote, no absolute proof can be brought forward to show that it is—no separation and chemical analyses as yet having been made of it. The contact between the epidote and hornblende is fairly sharp. The epidote is at times more or less surrounded by hornblende, but the immediate contact line is sharp.

A case like this was figured by Hobbs[†] from a gabbro diorite from Ilchester, Maryland. The micropegmatitic intergrowth, however, is not mentioned in the text, and but imperfectly represented in the figure. Through the kindness of Mr. Hobbs I was enabled to examine the section figured, and was thus able to satisfy myself of the similarity of the two occurrences, the one from Alabama being a much more perfect case, and the rock in which it occurs being far fresher than the Maryland specimen. In the article referred to the conclusion seems to be that, as suggested by Prof. Rosenbusch, "the mineral is amphibole in thin scales, the high colors resulting from intercalated films of air." This explanation could not be considered at all for the Alabama occurrence, as the mineral is seen to be perfectly compact and occupying the entire thickness of the section. However, as showing an excuse for the suggestion of the hornblende nature of the mineral, it may be mentioned that I found in one case, in Sp. 15, a micropegmatitic intergrowth of feldspar and hornblende on the edge of a large hornblende crystal, which bears a great resemblance in certain positions to the epidote. As soon, however, as the stage was revolved, the marked emphibole pleochroism became apparent, and agreed perfectly with that of the main mass of the crystal, and the cleavage could be followed extending from the compact main crystal through the micropegmatitic portion. Moreover the interference colors are not so high as are those of the epidote.

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[*] The Gabbros and Associated Hornblende Rocks of Baltimore, Maryland. G. H Williams, Bull. 28 U. S. Geol. Sur., 1886, p. 32.

[†] Some Metamorphosed Eruptives of Maryland. by Wm. H. Hobbs. Trans. Wis. Acad. Sci., Arts & Letters, Vol. 8, 1890. Fig. 1, p. 157.

In the cases of the epidote occurrences cited above by Williams and Hobbs (1. c.), they have been explained as reactionary rims between the feldspar and hornblende. Both rocks from which they have been derived have been much altered, and have clearly been derived from other rocks by dynamo-metamorphism. The one I have before me is, as above stated, perfectly fresh. Moreover, it has not been subjected to dynamic action, as is shown by the sharp extinction of all the mineral constituents. The position of the epidote proves it to be dependent for its origin upon the feldspar and hornblende. No evidence can be found in this specimen to support the view that the fringe was secondarily formed by a reaction between the feldspar and hornblende as a result of metamorphic action, however, for the rock has apparently undergone no such metamorphism. Since there is an absence of proof of its secondary nature, may we not, with some degree of probability at least, consider this micropegmatitic epidote fringe to be due to a somewhat similar process and condition as that existing during the formation of the well known micropegmatitic intergrowth so frequently seen around feldspars in the acid porphyries, the reaction upon each other of the feldspar and hornblende molecules remaining uncrystallized at a certain time resulting in a mineral of intermediate composition, the epidote, penetrated by the fresh clear rods of feldspar.

At the foot of the hill just before reaching Mr. Andrews's house, there outcrops on the right of the road, forming a small elevation, a coarsely granular rock, Sp. 17. This is also seen on the opposite side of the road outcropping in several small knolls, the general trend of the rock mass as indicated by the series of knolls being S. E.–N. W. Sp. 18 was taken from one of the knolls right by the negro cabin. As we ascend the hill upon which Mr. Andrews's house stands, we pass over light greenish, rather fine grained schist, Sp. 15, with schistosity striking S. E.–N. W. It is cut by six dikes, Sp. 19, from six inches to fifteen feet in width, which are very much altered, and now consist for the most part of chlorite. Prof. Tuomey says of the exposures :* "Near Mr. Andrews's house, vast and rugged masses of hornblende passing into soapstone are found protruding above the surface and not far from the house a trap dyke crosses the road, with which I found associated magnetic iron but not in great quantity."

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*2d Biennial Report of the State Geologist, 1858, p. 61.

Sp. 16. *Amphibolite* (*Hornblende-schist*).—This is a moderately fine grained light green schistose rock composed of common green hornblende, with magnetite inclusions in small quantity. No quartz or feldspar is present. The amphibole shows moderately strong pleochroism from light green to yellowish white. The extinction is sharp and the angle measured against the prismatic cleavage is low, the maximum of several measurements being 13 deg. A few of the crystals are colorless at one end and green at the other. Such crystals possess, however, the same optical characters throughout. Where the magnetite occurs it is always fresh. The rock in no wise indicates the manner of its origin or from what derived. It resembles very much Sp. 28 and 29 from West Point, Ga.

Cutting this schist we find, as first stated, Sp. 19, but as this is merely an altered phase of Sp. 18 and 17, they will all be described together and the process of alteration traced out. Although the large masses from which Sp. 17 and 18 were taken were not observed in contact with the schist, we may reasonably conclude, from the fact that they are igneous rocks, and the same as Sp. 19 which does cut the schist, that they would bear the same relations to it, if the rock was sufficiently exposed to allow the relations to be discovered.

Sp. 17, 18 and 19. *Hornblende Olivine Rock* (*Cortlandite*).—This is a coarse grained rock with dark green color, which upon weathering is covered wfth a ferruginous crust. It is a granular aggregate of hornblende, olivine, pleonaste, and magnetite. The hornblende differs from that usually found in such rocks in that it is a very light green, so that in thin sections it appears almost colorless, whereas in the rocks for which Williams* proposed the name *cortlandite* the hornblende was the brown strongly pleochroic variety. The hornblende angle and other characters prevent its being mistaken for a pyroxene. It is present in partially automorphic long prismatic individuals and is quite free from inclusions, only in a few cases containing magnetite and minute brownish plates. The olivine is in large grains between the hornblende crystals, and is for the most part altered to yellowish serpentine. Grains of unaltered fresh olivine still remain scattered through the serpentine. It contains a good many magnetite inclusions and also grains of green spinel. The light green isotropic mineral which is present in considerable quantity in irregular grains throughout the rock is a spinel and is presumed to be the iron-magnesia aluminate, pleonaste. It is usually associated with the magnetite, and is frequently seen forming a narrow rim completely or partially encircling it. This also contains numerous small crystals of magnetite. Magnetite is present in large crystals scattered through the rock, besides that enclosed in the other minerals. The secondary products are serpentine, chlorite, and calcite. The amphibole alters along cleavage lines and fractures to serpentine, and in places also to a chloritic mineral which is light green for the ray vibrating parallel to the cleavage, and yellow perpendicular thereto. The olivine alters to the characteristic serpentine with mesh structure.

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*Peridotites of the Cortland Series, by G. H. Williams, Am. Journ. Sci., iii, vol. 31, 1886, p. 30

Of considerable interest is the alteration which the green spinel undergoes. It shows in places an imperfect octahedral cleavage. Along these and fracture lines and around the edges it slightly alters to a white to brownish yellow substance in which still remain the magnetite crystals which are included in the fresh mineral. This substance by high power appears in places somewhat fibrous and seems to have at times a low polarization color and at others to be isotropic. The doubly refracting portion is presumed to be serpentine, a product which might readily be formed from such a ferro-magnesian alumniate. The isotropic portion is not determinable. So far as I can learn, no such alteration has ever been described for pleonaste in any rock. The spinels are usually described as perfectly fresh in all rocks in which they occur. It is one of the most resistant of minerals, and in such rocks remains perfectly fresh after the other minerals have altered, Here, however, we have it beginning to alter, even before the olivine has completely disappeared. Moreover, in Sp. 19, the most altered phase of the rock, the spinel is quite fresh. It would appear to be due perhaps to some special cause acting in the larger dike alone, The alteration is best seen in Sp. 17, and there I believe no one can be in doubt as to its being a true alteration. In Sp. 18 it is not quite so far advanced. Shepard mentions a partial pseadomorph of steatite after a green spinel, containing chromium, from N. Carolina.*

Sp. 20. *Amphibolite* (*Hornblende-schist*). Immediately after crossing the first large brook beyond Mr. Andrews's I collected a specimen from a rock outcropping in a small mass to the right of the road. Could get no good strike of schistosity. The rock is green, schistose, and medium grained. Under the microscope it is seen to be identical in character in fresh condition with the preceding amphibolite, Sp. 16. As it begins to alter, however, there is a change in the character of the rock. The amphibolite begins to bleach, the bleaching beginning along the edges. As a result of this bleaching we have an amphibole formed which is very much lighter in character than the original, and occurs not in compact masses but in more or less fibrous crystals with green color. It shows very slight or no pleochroism and possesses the characters of actinolite. Grains of calcite and magnetite are observed intermingled with this secondary amphibole, and are looked upon as products of the decomposition of the common hornblende. The magnetite has collected in aggregates of varying size, and is usually surrounded by the actinolite, mixed with grains of calcite.

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*C. U. Shepard: Corundum of N. Carolina and Georgia. Am. J. Sci. IV. 113, 1872.

At Mr. Joel Harris's Sec. 4 or 9, T. 20 N., R. 26 E., I collected Sp. 21 from the brow of the hill back of the house.

Sp. 21. *Diorite.* This is a black schistose rock, which upon examination proves to be diorite. The hornblende is the common compact green variety, strongly pleochroic, *c.* bluish green, *b.* yellowish green, *a.* light yellow, and occurring in thick forms approaching grains. It has all the appearance of an original constituent. The feldspar, which is a plagioclase, is without crystallographic contours. This is accompanied by a few unstriated grains supposed to be orthoclase. All of the feldspar is very fresh, showing in a few cases beginning cloudiness. Very little quartz is present. Epidote is found in a number of large crystals. Of all the minerals it has the best crystallographic outlines, in every case one or more crystal faces being developed. Some magnetite is present included in all other minerals.

Sp. 22. *Diorite.* From large boulders in situ in Mr. Joel Harris' pasture. This is the same as above except that the epidote is wanting. The extinction in both of these sections is sharp, indicating total absence of orogenic pressure. The schistosity is given to them by the general parallelism of the hornblende prisms, causing the rock to cleave readily in a certain direction.

Lafayette to B. F. Frazier's.

Going west from Lafayette upon the Dudleyville road we pass, just before crossing the large branch of the

Hoodlethlocco creek, about a mile from town, an outcrop of a green dioritic rock like Sp. 15 and 21. This is weathered to a depth of several feet, the weathered product being a yellowish brown porous rock through which are scattered black spots of limonite and in some cases glistening grains of quartz. This alteration product is quite common along the road from Lafayette to Oakbowery and to Dudleyville, but this was the first time it was seen in connection with even a fairly fresh rock. Usually only the porous brown alteration product remains. Near B. F. Frazior's, the old Holloway place, a low outcrop of quite rotten hornblende olivine rock, Sp. 23, was visited. This I was told had been used for making mantels in a few cases by some of the people living there.

Sp. 23. *Hornblende Olivine Rock* (*Cortlandtite*). This rock is of a dark green color, coarse grained, with the brown colored hornblende appearing in large porphyritic crystals, each surrounded by a narrow zone of lighter colored mineral.

Under the microscope it consists chiefly of large crystals of hornblende, grains of olivine and magnetite as primary minerals, and actinolite, talc, and chlorite as secondary products. The hornblende, in large plates, having macroscopically a brownish or bronze color, shows microscopically a yellowish to yellowish green tinge, and is very weakly pleochroic. It contains olivine and magnetite inclusions. It bleaches around the edges and forms lighter colored green amphibole. The alteration of the compact hornblende to the fibrous actinolite is very beautifully shown. With the alteration there follows the reduction of the extinction angle from 20° in the large plates to 18° in the fibrous actinolite surrounding it. It also alters to talc. The olivine is in large grains and contains magnetite and also some hornblende inclusions. It is remarkably fresh, beginning to alter along the edges very slightly. The magnetite is in considerable quantity in grains, and is included by all original minerals. As can be readily seen, the fibrous hornblende is formed from the compact variety. There is a large amount of this present. Talc is frequently found surrounding the hornblende and in the large plates also penetrates it along fissures. In the fissures it contains magnetite, just as the serpentine veins in olivine do, and appears to be without doubt secondary after the hornblende. There is a large amount of it present in the rock. Chlorite is found, but in rather small quantity.

Perhaps this is the rock to which Tuomey refers when he states 'that about seven miles west of Lafayette a trap dike comes to the surface.'* This is about that distance from the town, but I strongly suspect that he observed some of the dark schistose dioritic rocks like that which I mentioned above, and termed it a dike, as farther on he speaks of this dipping to the southeast. The rock from which the cortlandite came is perfectly massive. On the same page he speaks of the same series of rocks outcropping on the road to West Point, Ga. I passed the brown, rotton, weathered product of the diorites outcropping on the road to West Point also, but but no massive dike rocks. This brown alteration product is quite common around Lafayette.

West Point, Ga.

While waiting for a train here I visited a place where, according to Tuomey,† as near as I could judge from the location given, an interesting trap dike was to be seen. I collected several specimens of the rock outcropping, and it may be well to describe the section, as the same rock will probably be traced over into the Alabama territory.

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†Second Biennial Report of the State Geologist of Alabama, 1858, p. 63.

*Second Biennial Report of the State Geologist of Alabama, 1858, p. 63.

In the first deep railroad cut on the east side of the Chattahoochee river there is an excellent exposure of crystalline rocks. They possess a certain degree of schistosity, the strike of which is uniformly NE–SW and the dip to the NW 60°. The rocks are very much altered, though some specimens were obtained which were quite fresh.

Sp. 24. *Diorite.* This is an especially coarse grained rock, and under the microscope is seen to be composed of common green hornblende and plagioclase, with small amounts of orthoclase, quartz, and magnetite. The minerals are xenomorphic, but the plagioclase seems to approach nearer to being automorphic than any of the rest.

Sp. 25. *Diorite.* This is a trifle finer grained than the preceding and is composed of the same common green hornblende, plagioclase, very little orthoclase and quartz, considerable apatite in round grains, and some pink garnet and also magnetite. The garnet is automorphic. None of the other minerals show crystallographic boundaries. The minerals are very fresh under the microscope. The magnetite is beginning to alter, and colors the adjacent minerals with yellowish brown iron hydroxide.

Sp. 26 represents an advanced stage of alteration of rocks similar to 25, but containing a good deal of quartz, the only mineral now remaining. Otherwise it is a mere network of isotropic brown iron hydroxide.

Sp. 27 is the most advanced stage of similar rock. No mineral is seen at all in this, the quartz having failed in the original or else having been washed out, leaving merely the porous clayey ochreous mass.

Sp. 28. *Amphibolite (Hornblende-schist)*.—To the east of the coarse diorites there is exposed for nearly 150 feet a rock which is without stratification or marked schistosity. It is found mostly in irregular blocks separated by a sandy decomposition product. The rock itself has a rough sandy feeling. It is light green in color with a tinge of yellow. Under the microscope the rock is found to be made up of common green hornblende in irregular grains and prismatic crystals, and a monoclinic amphibole, colorless in thin section, which at times is intergrown with hornblende. A few grains of quartz were observed between the amphiboles. The rock is very fresh, and the decomposition seems to be merely a loosening of the grains, which allows the hornblende crystals to fall apart very readily. The two sections are very thick. It would be interesting to find out the relations of this rock to the rocks represented by Sp. 29 and 30, and thus determine its origin. I am unable to tell from the sections how the rock originated.

There occur interesting rocks. Sp. 29 and 30, exposed in numerous blocks on the surface above the railroad cut but not outcropping in the cut itself. These blocks are scattered along a ridge having its long direction extending approximately north-east and south-west.

Sp. 29. *Augite Norite or Hyperite*.—This is an exceedingly tough, medium grained green rock, which under the microscope has as constituents hypersthene, augite, hornblende, plagioclase, and magnetite. Hypersthene is in larger proportion than any other mineral and is present in short prismatic individuals without terminal faces. It is colored quite deeply and shows its characteristic pleochroism, *a*. red, *b*. yellowish red, *c*, green. Some but not all the crystals contain the reddish brown platy inclusions which are so frequently found in hypersthene. Fibrous green diallage is present in about equal quantity with the hypersthene. It is xenomorphic, and some of its crystals contain brown inclusions. It may be easily distinguished from the hypersthene by its high extinction angle and lack of pleochroism. Both the hypersthene and diallage have a mottled appearance between crossed nicols. This is especially marked in the diallage. It is seen to be due to included microlites with light green tinge, which from their high extinction angle are supposed to be some pyroxene mineral. Owing to the great thickness of the slide and strong color of the enclosing mineral, the difficulty of determining the microlites is greatly increased.

Hornblende is present in very small quantity. It occurs in a partial rim around the pyroxene. It is light green in color, compact, and apparently an original mineral. The plagioclase is found in very small quantity and forms xenomorphic grains filling in the angles. In a few places larger plates of it enclose the hypersthene individuals, giving a poikilitic structure. It also contains numerous light greenish undeterminable microlites. No iron ores are present; all of the iron present in the original magma having apparently been used in coloring the various minerals. All of the minerals are very fresh. The structure of the rock is granular. The above described rock bears remarkable resemblance to some of those described by Williams[*] from the Cortlandt series of New York.

Sp. 30. *Pyroxene Hornblende Rock.*—Macroscopically this is quite similar to the preceding, but one can readily see that there is a larger proportion of the light green hornblende present. The components of the rock are hornblende, augite and magnetite. The hornblende is in zenomorphic individuals, is compact, and is a light green variety of the common hornblende. It is original. The augite occurs in large plates enclosing small hornblende individuals. It is also compact, of a pink color, and with very slight pleochroism. Both the pyroxene and hornblende contain numerous inclusions of magnetite. In addition to these inclusions the magnetite also occurs in large crystals scattered through the rock. No feldspathic mineral is present, and the structure is granular. This is a peculiar facies probably of the same magma from which the norite is separated, as would appear from their intimate association.

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[*] Am. Journ. Sci., iii, Vol. 33, 1887, p. 193.

These are exceedingly tough rocks, forming apparently the ridge extending north-east from the railroad cut. Along this ridge these boulders are found scattered in intimate association, though the relations of the one to the other could not be observed. There are several pits which have been sunk in search of copper at various points on the ridge, and it was probably from one of these that Tuomey collected the serpentine, Sp. 31. The sides of the pits have now caved in, or else have been otherwise filled with debris.

Sp. 31. *Serpentine.*—Macroscopically the rock is greenish brown and very dense. Under the microscope it is so completely altered that a spinel and magnetite are the only original minerals left. Some secondary calcite is present and also a chlorite mineral. The spinel is not as green as that described from the Cortlandtites, but has a decided brownish tinge, and is probably quite close to picotite. I am unable to tell from the rock what might have been the constituents of which it was originally composed.

The ridge formed by the norite and pyroxene-amphibole rock was followed for three-fourths of a mile and then died out. I continued on to the river hoping to find these rocks outcropping in the banks or bed, but did not find them. The river where I touched it was being channeled and jettied, and the blasting had brought fresh rock from the river bed to the surface. A couple of specimens, 32 and 33, were taken.

Sp. 32. *Biotite Hornblende Gneiss.*—This is a medium grained gray well laminated rock. The micaceous bands give it its marked gneissoid structure. It is composed of common green hornblende, which predominates, brown biotite, pleochroic from an almost opaque chocolate brown to pale yellow, plagioclase, doubtfully orthoclase, quartz, sphene, pleochroic from yellow to pink, apatite, zoisite, and magnetite. Calcite is present in grains and has not the appearance of an infiltration or secondary product. All of the above minerals show their common characters. Undulatory extinction and bent twinning lamellae were common.

Sp. 33. *Diorite.*—This is a medium grained black rock with granular structure. It is composed of hornblende, biotite, plagioclase, orthoclase, quartz, spene, and magnetite. The hornblende is dark green, compact, and strongly pleochroic. It occurs in grains. Biotite forms regular plates with strong absorption from yellow for rays vibrating parallel to cleavage to chocolate brown for those perpendicular thereto. It is not present in very large quantity. Plagioclase is the prevailing white silicate. It is xenomorphic and contains numerous minute plates of rounded and oval shapes, which are transparent with a brownish color. A few rare unstriated feldspar crystals (orthoclase) were observed. Quartz is present in a few grains. Sphene is scarce. There is quite a good deal of magnetite.

Sp. 34. *Amphibolite* (*Hornblende-schist.*)—This slide was cut from a specimen which was labelled by Tuomey as having come from West Point, Ga. It was found in the University collection at Tuscaloosa. It is a coarse grained schistose rock. The microscope shows no constituents but a very fresh compact common green hornblende in large prismatic crystals.

Conclusions.—In the preceding pages I have described a series of rocks consisting of sedimentary and igneous

rocks and also certain schistose crystalline rocks whose origin is unknown, and which are usually included under the general name crystalline schists.

Sedimentaries:

Spec. 9, Quartz schist.
" 14 " "

Eruptives:

Spec. 2, Biotite granite.
" 3, " " (gneissoid.)
" 4, " " "
" 5, Leucite tephrite.
" 6, Biotite granite.
" 8, Diabase.
" 10, 11, 12, 13, Biotite gneiss (metamorphosed granite.)
" 15, Diorite.
" 17, 18, 19, Hornblende Olivine Rock (Cortlandtite.)
" 21, Diorite.
" 22. Diorite.
" 23, Hornblende Olivine Rock (Cortlandtite.)
" 24, Diorite.
" 25, Diorite.
" 26 and 27, Alteration products of Diorite.
" 29, Augite Norite.
" 30, Hornblende Pyroxene Rock.
" 31, Serpentine.
" 33, Diorite.

Crystalline Schists.

Spec. 16, Amphibolite.
" 20, "
" 32, Biotite gneiss.
" 34, Amphibolite.

Of these the sedimentaries are comparatively unimportant, their relations not having been observed.

The igneous rocks are the most numerously represented, and are by far the most interesting. Individually Sp. 18 is worthy of notice on account of the alteration of the green spinel, pleonaste, this being, as far as I can learn, the first rock in which such an alteration has been observed. In this connection attention may be called to the fact that the iron ore and emery segregation veins of the Cortlandt series,[*] which contain large amounts of pleonaste according to Williams,[†] occur in rocks related to this.

A spinel occurring with corundum in association with serpentine rocks has been reported from Dudleyville, Ala., a locality not very far distant from the point where the Cortlandtite is found. May not this be an occurrence similar to the iron ore, emery and spinel association from the "Cortlandt Series?"

Sp. 29, as an excellent type of augite norite, and Sp. 15, in which the micropegmatitic intergrowth of epidote and feldspar is to be seen, are also interesting. Sp. 10, 11, 12, 13 are remarkably fine examples of a dynamo-metamorphosed rock.

The general assemblage of eruptive rocks bears a striking resemblance to certain types described from the Cortlandt area of Westchester county, N. Y., and from Baltimore, Md., by Williams,[‡] from Delaware by Chester,[§] and from Ilchester, Md., by Hobbs[‖].

They are also closely related to the peridotites described from North Carolina by Julien,[*] Wadsworth,[†] and Williams,[‡] and from Kentucky by Diller.[§] The distribution of such rocks is thus shown from the extreme south-east extension of the Appalachian system in Alabama almost throughout its entire length. It is highly probable that further researches in the region from which the above specimens were gathered will disclose another such beautiful case of magmatic differentiation as was described from the Cortlandt series by Williams,[‖] and of metamorphism of the gabbros and diorites as illustrated in the papers of Williams, Chester and Hobbs, above referred to.

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[*] Dana, Am. J. Sci. XX, 1880, pp. 199-200.

[†] Norites of the "Cortlandt series." Am. J. Sci. 33. 1887, p. 194. Uber Pleonaste and Hercynite. N. Jahrb. II, 1887, p. 263.

[‡] Cortland Series. Am. Journ. Sci. iii, vol. 31, 1886, pp. 26-41; vol. 33, 1887, pp. 135-200: vol. 35, 1888, pp. 438-448.

[§] Gabbros and Associated Rocks in Delaware. Bull. 28, U. S. G. S., 1890.

[‖] Some Metamorphosed Eruptives in the Crystalline Rocks of Maryland. Trans. Wis. Acad. Sci., Arts & Letters, vol. 8, 1890, pp.

I have left with the igneous rocks a few specimens, 4, 6, 7, 10, 11, 12 and 13, whose schistose condition alone would cause them to be placed in the succeeding category of crystalline schists, but which after microscopical study seemed to me to be of eruptive origin. It would perhaps have been well to have placed Sp. 15, 21, 22, 24, 25 and 33 under the crystalline schists as plagioclase amphibolites. They, however, bear such a striking resemblance to similar rocks, which after a careful and very detailed study of their field relations, have been proved to be diorites, that I have retained them among the eruptive rocks.

The crystalline schists include those which are markedly schistose and whose origin is entirely unknown. They were found associated with and cut by the igneous rocks. Future studies may show them to be metamorphosed phases of some of the eruptives.

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[*] Proc. Boston Soc. Nat. Hist., vol.

[†] Olivine Rocks of North Carolina. Science, vol. 3, No. 63. 1884, p. 486.

[‡] The Non-feldspathic Intrusive Rocks of Maryland and the Course of their Alteration. Am. Geol., vol. 6, 1890, p. 44.

[§] Peridotite from Elliot county, Ky. Am. Journ. Sci., iii, vol. 31. 1886, p. 121: Bull. U. S. G. S., No. 38, 1887.

[‖] l. c.

Taking the rocks as a whole, disregarding the quartz-schist, their general characters are those of that great mass of rocks which lies below all beds of undoubted sedimentary origin, and which are known as the Archaean rocks.

Supplementary Notes of Dr. Clements.

In the summer of 1894, I collected from the vicinity of Gold Hill, in Lee county, and from a railroad cut near Dadeville, specimens of eruptive rocks which were submitted to Dr. Clements for examination. His report is as follows:

"No. 1. (35) From near Gold Hill, Lee county. This is a very fresh specimen of a typical *Olivine-diabase*. Fine grained. The mineral constituents given in order of age are, apatite, triclinic feldspar (anorthite), olivine, magnetite, augite. Feldspar and augite predominate, then comes magnetite with very little olivine and apatite. The triclinic feldspar is *anorthite* and occurs in long lath-shaped individuals showing polysynthetic twinning. It is for the most part quite fresh. Beginning decomposition makes the plates appear somewhat dull. In a more advanced state these dull spots are seen to be made up of minute grains of epidote. The *augite* is in very light brownish grains and wedge-shaped pieces which lie between the feldspar individuals, as a cement, and from them have received their outlines. The characteristic cleavage angle is well marked. Augite is very fresh. *Magnetite* appears in irregular individuals with only one or two crystal faces developed, the rest of its contours being determined by the feldspar crystals touching it. *Olivine* is present in only one large crystal. It is partially altered, serpentine forming around the edges and along the cleavage lines. A few obscure greenish spots in the ground mass may be completely altered olivines. *Apatite* is scarce, occurring in long needles penetrating the other minerals. The structure of the rock is typical ophitic.

No 2 (36). From railroad cut near Dadeville. *Hy-*

persthene-gabbro with a great deal of hornblende and biotite; might be called a *hypersthene-hornblende-biotite gabbro.* Coarse grained, granitic structure.

Hypersthene, the most characteristic mineral, occurs in rounded crystals surrounded by a border of compact green hornblende. Between the hypersthene and hornblende there is frequently a zone which is made up of the hornblende intergrown with a white mineral of very low angle and double refraction, probably feldspar. Hypersthene is pleochroic, from pink to light greenish tinge. The characteristic brown inclusions are present. It is very fresh, only in places along cleavage lines are there traces of beginning decomposition. *Diallage* is present in comparatively small quantity and is surrounded by the strong pleochroic green hornblende just as the hypersthene is. *Hornblende* occurs in a few large plates in the section, but for the most part as a border, varying very much in width around the pyroxene crystals. It is very pleochroic, the color changing from light yellow to bluish green and dark olive green. It contains numbers of dark interpositions, different from those in the hypersthene, in the form of rounded plates and long needles. Some of the apparent needles are undoubtedly only the plates on edge. For the most part they are perfectly opaque, but some permit a little light to pass through and are of a dark chocolate brown. The characteristic hornblende cleavage is frequently seen. It includes plates of biotite and large crystals of apatite and magnetite. *Biotite* appears in plates with its customary strong pleochroism, straw yellow to chocolate brown, and perfect cleavage. It is included both in the pyroxene and hornblende. *Feldspar* forms the mass of the rock and appears in polysynthetically twinned grains. It is the basic *anorthite,* and is perfectly fresh and clear. *Magnetite* is in rounded grains and is included in the other minerals. *Apatite* occurs quite abundantly and in large crystals which have more or less rounded outlines. Feldspar, hypersthene and hornblende make up the mass of the rock, then diallage, biotite, magnetite and apatite. The structure is granitic, and the specimen is remarkably fresh.

No. 3 (37). *Hypersthene-hornblende-biotite-gabbro.*—Same locality as the preceding. What is said of No. 2 holds good for No. 3, except that the latter contains rather more diallage in proportion to the other constituents and also more biotite and apatite. In a few places the feldspars show signs of deformation in bent twinning lamellæ. This is, however, apparently only local, as it is seen only where decomposition has begun, and may be due to the hydration of the feldspar exerting pressure on the surrounding crystals."

In the following notes by Dr. Clements, Nos. 38, 39, 40 and 42, descrie the chief varieties of the green schists of the Hillabee type. Nos. 41 and 43 are probably altered sedimentary rocks; the latter is of some interest for the reason that in it through Clay county and parts of Coosa many years ago great numbers of pits have been sunk in the search for copper. The graphite seems to have been the attraction, and the prime cause of the search. I am not aware that copper has been anywhere found in it. No. 41 is a sample of the graphitic schist which extend through Coosa county parallel with the course of Hatchet creek and at no great distance therefrom:

(38) 1. Actinolite-epidote-schist. From McGhee's, Clay Co.

This a very fine grained compact grayish green schist, composed of epidote, in grains, lying in a fine felt of actinolite needles, with here and there a lenticular area of quartz. Nothing in it gives an indication of the origin of the rock.

(39) 2. Sericite-schist. From McGhee's, Clay Co.

This is macroscopically a light dirty yellow, schistose rock, with silky luster upon the faces parallel to the schistosity, and showing on traverse fracture a well marked "augen" structure on a small scale, a dark mineral forming the center of the eyes. Under the microscope the rock is seen to be composed of thin alternating bands of two kinds, one of which is composed essentially of cataclastic quartz, with a small amount of unstriated feldspar, the other of sericite, scattered actinolite needles, and a large quantity of small epidote grains. These sericitic bands show a very noticeable wavy structure, and extend across the thin section in undulatory lines, separating here and there to wrap around the hornblende which forms the eyes. Upon examination these eyes are seen to be made up of a number of fragments of a very dark green hornblende. The fragments in most, if not all, cases belong together, showing from the manner in which they are separated the crushing which the rock has suffered. The hornblende is compact in the center and cloudy with minute dark specks, but on the edges it is light colored, frayed out as it were, and passes over into aggregates of actinolite and epodite lying in quartz cement. As we go away from these eyes the quartz diminishes in quantity, and the actinolite also. Sericite begins to increase, and we pass over into the bands consisting of sericite and epidote, with a few needles of actinolite, and so dense that the quartz can not be distinguished. The quartz bands have scattered actinolite needles and epidote grains in them here and there, and also a few flakes of sericite. The crushed character of the hornblende and quartz is sufficient evidence of the dynamo-metamorphic action to which the rock has been exposed, but no satisfactory proof of its original condition could be found. My belief is that it was not derived from a clastic, unless it was itself metamorphosed, but was derived from some eruptive rock.

(40) 3. Actinolite-epidote-zoisite-schist. Chandler's Spring.

This is a quite rotten, fine grained gray rock macroscopically. Besides the actinolite, epidote, and zoisite, it contains a small quantity of granular quartz, and is badly discolored by brownish iron hydroxide. It bears now no evidence of clastic origin, but it would really be impossible to say from what it was derived, whether from an eruptive or a sedimentary.

(41) 4. Graphite-schist. Ingraham's Mill. Clay Co.

This appears very much like the phyllites, exceedingly fine grained and fissile. It consists of a fine grained granular aggregate of quartz and feldspar, with rounded zircon crystals and fragments of tourmaline and flakes of sericite. The rock is rendered quite dark by innumerable minute needles of rutile and a black substance which is scattered all through it, occuring in specks without any determinable form. This substance has a black metallic luster in incident light, disappears when the rock is heated to a high temperature, and was determined to be graphite. Part of the rock is discolored by brown iron hydroxide derived from the alteration of ferruginous carbonate, which occurs in well developed rims in parts of the rock. If, like many others, you consider the presence of graphite as sufficient evidence of the existence of living organisms from which it was derived, then the original sedimentary character of the rock is proven, although now it is so metamorphosed that it contains no indications (other than the presence of graphite) of its origin.

(42) 5. Actinolite-schist. Lecroix, (Millerville,) Clay county.

Fine grained green schist, seen under the microscope to be composed of actinolite, epidote, flakes of chloritic material, and sphene, in a clear granular groundmass of clear unstriated feldspar and some quartz. The granular aggregate is rendered schistose by the parallelism of the actinolite needles and chlorite flakes. It is impossible to determine the original character of the rock.

(43) 6. Graphitic muscovite-schist. J. W. House. Clay Co.

Macroscopically the rock is a medium grained grayish-blue schist, showing large light greenish clumps of muscovite. Under the microscope it is found to be composed of quartz, muscovite, and graphite, with spots of white opaque leucoxene-like substance. Cataclastic structure is very plainly shown by the quartz. If the graphite is here, as in No. 4, to be considered sufficient evidence of life, it is probable that the rock is of sedimentary origin, though it exhibits now no sedimentary character.

(44) 7. Mica-schist (shistose eruptive rock). Darsey No. 4. Coosa Co. A dark bluish-black fine grained more or less schistose rock. Under the microscope we find a few eyes of grayish and altered triclinic feldspar, which lie in a fine grained cataclastic groundmass composed of quartz and feldspar mosaic—in which the quartz predominates—with flakes of brown mica and some chlorite. There are also found large quantities of sericite, with a considerable quantity of fairly large crystals of epidote, and rare ones of reddish sphene. The mica and epidote are present in large quantities, and almost obscure the clear white elements of the groundmass. The rock is clearly at present in a very badly mashed condition, and was probably derived from

an acid, granitic eruptive.

(45) 8. Amphibolite or hornblende schist. Darsey No. 5. Coosa Co. Dark green schistose rock made up of strongly pleochroic, common green hornblede in small partly automorphic crystals, together with a large quantity of magnetite and considerable epidote, in a granular groundmass of unstriated feldspar, with some quartz. The hornblende is beginning to get fibrous along the cracks which traverse the crystal perpendicular to prismatic cleavage. The rock is now a crystalline schist, of which nothing more can be said than that it was probably derived from some such basic eruptive as probably a gabbro.

3. PRELIMINARY PETROGRAPHIC NOTES ON SOME METAMORPHIC ROCKS FROM EASTERN ALABAMA,

BY

ALFRED H. BROOKS,

ASSISTANT GEOLOGIST, U. S. GEOLOGICAL SURVEY.

The following notes are the results of a brief examination of some twenty specimens which were submitted to me by Dr. Smith. No attempt has been made to go into minute mineralogical details, the determination of which will require further study. The naming of the rocks is only tentative, until further petrographic investigation and chemical analyses shall determine their true classification.

The metamorphic rocks of Alabama and Georgia may be differentiated into two series. The older, or crystalline series, includes crystalline schists and gneisses, whose origin is doubtful, together with large masses of gneissoid granite. The younger, or clastic series, is typically made up of phyllites, sericite schists, chlorite schists, conglomerates, usually containing much feldspar, quartzites, crystalline sandstones, and, in a portion of the region, limestones and marbles. In many cases this younger clastic series has been so metamorphosed that it is difficult to distinguish its members from the older crystalline complex. The rocks of both series are closely associated with rocks of undoubted igneous origin.

In some portions of the area there are broad belts in which the country rock is largely igneous. Such a zone of igneous rocks, which are chiefly basic, extends through the northern portion of Cobb County, through the central portion of Paulding into Carroll County, Georgia.* Another area of igneous rocks, which are also chiefly basic, has been mapped by Mr. Hayes in the southern portion of Cleburne County, Alabama.† The granites associated with the crystalline schists of the basal complex have already been mentioned.

The major portion of the igneous rocks of the two series are intrusive, but it is probable that further investigation will prove that some of the metamorphic schists of the region are altered effusive rocks.‡ Most of the igneous rocks seem to have been intruded previous to the deformation of the associated rocks, for, as a rule, they give evidence of having suffered extreme dynamic metamorphism.

CLASTIC ROCKS.

Among the twenty specimens submitted to me, only one rock (No. 2) showed any evidence of clastic origin.

No. 2. (101a and 101b) Locality: Blake Mountain, 3 to 4 miles south of Arbacoochee, Cleburne County, Alabama.

Siliceous-magnetite schist. Megascopically this is a fine-grained siliceous rock of dark blue color. It is irregularly banded by alternating layers of magnetite and vitreous quartz. Small crystals of garnet form "knoten" on the cleavage surface of the schist. A rough separation of the magnetite and quartz, gave about equal volumes of each.

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*Unpublished Tallapoosa and Cartersville folios.

†See also Geological Map of Alabama, published in 1884, where the area is also shown. E. A. S.

‡A microscopic examination of a specimen from Owl Creek, 2 miles south of Lovingood's Bridge, Cherokee County, Ga., shows it to be an acid effusive rock. Prof. Williams described a porphyry from the "Archæan Area of Georgia near Tennessee" in American Journal of Science, Vol. 7, No. 6, p. 57, July, 1893.

A microscopic examination confirms the above, and proves that quartz and magnetite are the essential minerals of the rock. The quartz occurs as a fine mosaic of interlocking grains. Much of it is presumably of clastic origin. Some of the quartz has, what is apparently, an inner clastic grain, which has been enlarged by a secondary deposition of quartz, oriented in optical continuity with the original grain. Secondary quartz also occurs as interstitial deposits between the original grains. Magnetite occurs sparingly as octahedral crystals, but usually as irregular masses and very fine grains. Magnetite is in many cases included in the secondary quartz as fine grains. Some of the magnetite is surrounded by a zone of leucoxene, which suggests that it is probably titaniferous. No garnets were observed in the thin sections.

This rock is part of a metamorphic zone which has been mapped by Dr. C. Willard Hayes, U. S. Geological Survey, as crossing the southeast corner of the Anniston sheet near Micaville.[*] This zone consists of garnetiferous, siliceous, and kyanite schists, and is probably a part of the younger clastic series.[†] The metamorphism may be regional but the proximity of large intrusive masses of diorite rocks, suggests a local cause.

GNEISSES.

Under this heading I have grouped the rocks which have no very close affinities but all show a gneissoid structure.

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[*] I am indebted to Mr. Hayes, of the U. S. Geological Survey, for the use of his notes on the unpublished Anniston and Tallapoosa folios, and for much general information in regard to this region.

[†] The Geological Map of the State, published in 1894, shows with approximate accuracy, the position of this zone which is part of the Talladega slate series. E. A. S.

No. 1. (100a and 100b) Locality: Country rock from Arbacoochee, Cleburne County, Alabama. *Biotite-chlorite gneiss.* Megascopically, the hand specimen shows this to be a grey-green colored rock, having a rather indistinct foliation. The foliation is produced by seams of dark green minerals which are mostly chlorite and biotite. Quartz and feldspar occur in irregular masses, which are somewhat elongated, and roughly parallel.

The microscope discloses a rock made up of feldspar (plagioclase?) largely replaced by secondary minerals: quartz, much of which is secondary; biotite partly altered to chlorite; a few scattered grains of augite: epidote, and a little muscovite.

Where the outline of the feldspars can still be traced they appear as tabular idiomorphic crystals. Much of the feldspathic material is replaced by quartz, as mosaics of interlocking grains, or by epidote and zoisite. Faint traces of either lamellar twinning or Karlsbad twinning can usually be observed in the altered feldspar. Under crossed nicols the outline of the original feldspar is often entirely lost, for there is a gradual merging into the groundmass. In some cases a zone of clear fresh-looking feldspathic material surrounds the altered feldspar phenocryst. This outer rim, which must be a secondary enlargement, shows no twinning and is probably albite. The original rock seems to have contained plagioclase and orthoclase in about equal proportions.

Quartz occurs as irregular mosaic patches of interlocking grains, which are probably recrystallizations of the silica of single quartz individuals, or replacements of feldspars.

The groundmass consists of allotriomorphic grains of quartz interwoven by irregular stringers of biotite and chlorite. Biotite and chlorite also occur in larger masses, which are always elongated and have a rough parallelism, thus giving the rock its foliated structure. Epidote occurs in the groundmass, and also as a secondary mineral after plagioclase, in small prisms. The zoisite, secondary after plagioclase, occurs as very fine grains and granular aggregates. This rock probably belongs with the gneisses of the basal complex, although the typical gneiss differs from this in having a granular instead of a porphyritic structure.

No. 14b. (114a and 114b) Locality: 1 mile north of West Point, Georgia, in Chambers County, Alabama.

Biotite-gneiss: Megascopically, this is a gray and white banded rock; the dark bands consisting of biotite and a ferro-magnesian silicate, and the light bands, of white feldspar and glassy quartz.

A microscopic examination shows the rock to consist essentially of quartz, biotite, feldspar, and hornblende. It has an orignal granular structure, with a secondary foliated structure.The segregation of the basic minerals into parallel zones gives it the banded appearance.

The quartz and feldspar occur in allotriomorphic grains, and individuals. Except some of the fine quartz grains, which are probably secondary, both quartz and feldspar are cataclastic. All of the feldspar shows polysynthetic twinning.

Biotite and green hornblende are present in about equal proportions and are closely associated. Biotite occurs in irregular shreds and plates, and the hornblende in deformed prismatic crystals. As an accessory constituent there are present a few grains of augite, and considerable brown tourmaline in small grains. A little chlorite is found in the rock as a secondary mineral after biotite.

The locality of this specimen is so isolated that a lithologic correlation can be of little value. It bears a close resemblance, however, to the specimens of gneiss which were collected from the basal complex of Cleburne County, Alabama, and Carroll, Cobb, and Cherokee Counties, Georgia. The rock in question (14b) differs from the other gneisses in respect to the predominating ferro-magnesian silicate. In this specimen from Chambers County (14b), hornblende is very plentiful, while augite is only an accessory mineral. In the other gneisses, from the region farther north, augite predominates very largely over hornblende.

Nos. 15 and 16. (115a, 115b, 116a, 116b.) Locality: Wright's Mill, near Auburn, Lee County, Alabama.

Augen Gneiss.—Megascopically the rock consists of a dark groundmass of mica, filled with augen of quartz and feldspar. The augen are either lenticular, or drawn out to thin seams. They vary from two inches to microscopic in diameter.

Microscopic examination shows that this rock contains quartz and feldspar, as minerals forming the augen, and biotite, chlorite, and epidote in the groundmass.

The quartz, where it is not completely granulated, gives wavy extinction, except in a few cases, in which it seems to be secondary. The feldspar is for the most part plagioclase, but a few large phenocrysts of orthoclase, showing Karlsbad twinning, were also observed. Structurally the augen are of two kinds. First, those formed of single mineral individuals; and second, those formed of an aggregation of minerals. The extreme mechanical deformation that this rock has undergone, is well shown by the granulations and alterations to which the augen have been subjected. In many cases the phenocrysts of feldspar or quartz, have been granulated on opposite sides, corresponding to the direction of the schistosity, and the material thus formed has been drawn out into a lenticular-shaped mass, with the solid portion of the minerals as a nucleus. In other cases the original phenocryst has been entirely granulated, and the material thus formed has been drawn out into a lenticular-shaped mass, or sometimes even into a mere thread.

In many cases the augen are not phenocryst, but are probably parts of the original rock, which have been separated by the lines of shearing, now marked by the groundmass of biotite and chlorite. These composite augen have the same lenticular shape and granulated boundaries as the simple augen. The composite augen have a holocrystalline structure and are composed chiefly of plagioclase feldspar, with some orthoclase and quartz, and a little biotite and epidote. It is possible that they are not fragments of the original rock, but are the results of the recrystallization of the feldpathic material, of single phenocrysts.

The groundmass of the rock consists chiefly of biotite, which has been greatly squeezed, and bent to conform to the countour of the augen. A little chlorite is associated with the biotite. Grains of epidote are scattered throughout the groundmass. Small lenticular grains of quartz are also found in the groundmass.

As in the case of the last described specimen, the locality of this rock is too remote from that at which any other material was collected, to make a lithologic comparison of any interest. Before its mechanical deformation it seems to have been a basic or intermediate porphyritic rock. The present dark silicates of the rock are probably all secondary, and afford little information as to its original mineralogical composition.*

IGNEOUS ROCKS.

The rocks of the metamorphic area of Alabama, and the adjacent portions of Georgia, have been exposed to the disintegrating atmospheric agencies during two periods of base leveling, and are therefore deeply weathered. The petrographical investigation of these rocks is attended with difficulties, for it is seldom that specimens can be secured from below this zone of weathering.

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*See also Dr. Clements' description of the same rock. E. A. S

Nearly all the rocks examined by me from this region, contained an abnormally high percentage of quartz. In many cases a part of the quartz is plainly secondary, being deposited subsequent to the deformation of the rock; while in other cases, the existence of two generations of quartz seemed probable, though positive evidence was wanting. The source of the silica of the secondary quartz can usually be traced to the breaking down of the silicates of the feldspars, but in some instances it seems to have been derived from infiltrating solutions. In the basic rocks, secondary quartz is frequently accompanied by calcite. The kaolinization of the feldspars and chloritization of the dark silicates are among the most frequent observed phenomena, accompanying the weathering of these rocks.

Besides these superficial alterations, many of the igneous rocks of the region have been subjected to the metasomatic and paramorphic changes which accompanied the mechanical deformation of the province. A rock which has suffered these various phases of metamorphism is frequently entirely altered, both as to chemical composition, and physical structure. The determination and classification of the igneous rocks of the region, is therefore, a difficult problem.

ACID ROCKS.

Granite is the prevailing type of acid rock, and in fact the only one which has thus far been definitely determined. Some rocks which have been classed as granites may prove to be syenites, their quartz being secondary. There are also, in the region, some aplite dikes which are apophyses from larger granite masses.

The granites have two distinct phases, between which, however, there are intermediate types.

The more acid granite is made up of quartz, orthoclase, microcline, muscovite, and biotite, with very little lime soda feldspar, together with accessory minerals. The more basic type is an aggregate of quartz, orthoclase, microcline, with considerable plagioclase, and biotite, hornblende, together with accessory minerals.*

Of the twenty specimens sent by Dr. Smith, fifteen were classed as igneous or altered igneous rocks, and of these only one is an acid rock.

No. 17. (117a and 117b). Locality: 3 miles west of Loachapoka, Lee County, Alabama.

Granite.—This rock shows a typical granite structure. Pink feldspar, glassy quartz, and biotite can be distinguished megascopically.

Microscopically, the rock has granular structure and the mineral constituents are all allotriomorphic. The feldspars are chiefly potash-feldspars, both orthoclase and and microcline being present. The orthoclase shows no twinning, while the microcline shows the double twinning, giving the characteristic cross hatched structure. A multiple twinning feldspar which is present in limited quantities is probably albite. The feldspars when not too much decomposed show more or less cataclastic structure.

The quartz of the granite, which occurs in irregular masses, is much fractured and gives wavy extinctions.

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*The rock from Stone Mountain, Georgia, is an example of this granite. The occurrence described by C. W. Purington, in The American Geologist, Vol. XIV, p. 105. August, 1894.

Biotite is uniformly distributed through the rock, as small scales and plates. Magnetite occurs sparingly as accessory mineral. Muscovite and kaolin are present as decomposition products of the feldspars.

This granite belongs to the more acid type described above. Mineralogically this granite is quite similar to one collected by Mr. Hayes near Mount Zion, Carroll County, Georgia. The Mt. Zion granite has, however, been subjected to mechanical deformation, which has given it a secondary parallel structure.

BASIC ROCKS.

The greater part of the basic rocks of the region can be embraced under the field terms, "greenstones," and "greenstone schists." These rocks are even more liable to alteration by atmospheric agencies than the acid rocks, and are correspondingly difficult to determine. In the collections made by Mr. Hayes and myself, there are examples of diorites, gabbros, diabases, pyroxenites, together with many hornblende, chlorite, and epidote schists whose antecedents are more or less doubtful. This collection includes no olivine bearing rocks, but Dr. Smith* has described an olivine rock from near Notasulga, Alabama.†

The talc (soapstone) slates which are not uncommon in this metamorphic area, are probably alteration products of very basic rocks, but as far as I know they have received no petrographical study. The rocks associated with the corundum deposits are also of very basic nature.[*]

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*Outline of the Geology of Alabama.

†This is the Ossipyte described by Prof. Hawes, No. 22 of his list. Other olivine-bearing rocks see the notes of Dr. Clements on specimens No. 17, 18, 19, and 23, and also on the specimen from near Gold Hill, in Lee county, No. 35. E. A. S.

The basic rocks of Alabama have been described by Dr. Smith and his assistants as hornblendic gneiss, hornblende schist, diorite, talcose slate, steatite and chloritic schists, in the various publications of the Survey. In Georgia[*] McCallie and King have classed the basic rocks as hornblende gneisses, hornblende rocks, periodotites, etc.

Like the acid rocks, the basic rocks are characterized by a high percentage of quartz, most of which is plainly secondary. In at least one instance an isotropic substance was observed which resembled opal.[†] The other secondary minerals observed are calcite often present in large quantities, hornblende and uralite, albite (?) (No. 5), epidote, zoisite, chlorite, leucoxene, garnet, and spene. Two examples of saussurite gabbro have been recognized[‡].

It is evident that the above list includes both the secondary minerals which are the result of dynamic metamorphism, and those which owe their existence to atmospheric action, or weathering.

Regarding the occurrence of the basic rocks, as far as our present knowledge goes, they are all intrusive. They occur as dikes, and larger intrusive masses, in both the older and younger series. the larger masses, however, seem to be confined to the basal crystalline series. As these basic rocks show wide differences in their relative amount of metamorphism, it is probable that there was more than one period of intrusion. As yet the relative ages of the different types of basic rocks, have not been determined. In general the basic rocks occur in broad belts which have considerable extension along the strike. Such a belt has been mapped by Mr. Hayes and his assistants extending through Cobb, Paulding, into Carroll counties, Georgia, and judging from specimens sent me by Dr. Smith, it extends into Randolph county, Alabama.

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[*] See Bulletins 1 and 2, Geological Survey of Georgia.

[*] Preliminary Report on the Corundum Deposits of Georgia, by Francis P. King, Geological Survey of Georgia, Bulletin No. 2, pages 71-4, 80.

[†] No. D 6. Chestnut Gap P. O. Gilmer Co., Ga.

[‡] Nos. D 7 and D 11, from near Allatoona, Bartow Co., Ga.

Until more material has been collected, with the end in view of tracing one phase of a rock into another (for example from massive to schistose) the classification of these basic rocks must be more or less arbitrary. For convenience of description I have divided them into schistose and massive rocks. The term schist is used in a relative sense only, for as a matter of fact nearly all these basic rocks have a more or less well marked cleavage.

Diorites.

Diorites are the most common basic rocks of this region. They occur as dikes in the younger series, and as dikes and larger intrusive masses in the basal crystalline series. There are two main types:* The quartz diorites in which quartz is a prominent mineral, and the ordinary diorites, in which it plays only a secondary part. We are here again confronted with the difficulty of determining which is primary, and which is secondary quartz, but it seems probable that the quartz diorite type predominates in the region. Dr. Smith sent me one each of these two types.

It should be noted that in these altered rocks it is not always possible to determine whether a rock should be classed as a diorite, or as an epidiorite. The alteration of augite to compact hornblende and uralite is a common paramorphic change, and with limited amount of material, it is often not feasible to determine whether the amphibole be primary or secondary. As a temporary expedient, therefore, I have classified the rocks showing little or no ophitic structure, and in which the feldspar is an acid labradorite, as diorites, unless the amphibole is plainly secondary after augite. The rocks which had a marked ophitic structure, and whose feldspar was the more basic labradorite, I have classed as diabases, or epidiorites as the case may be.

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*It should be noted that no chemical analyses have been made of these rocks, and the percentage of silica may prove to be so high that they can not be classified as basic rocks.

No. 14a. (113a and 113b) Locality seven or eight miles north of Columbus, Georgia, in Lee county, Alabama.

Diorite.—Megascopically a green and white speckled, medium grained rock, in which hornblende, feldspar and quartz can be distinguished.

Microscopic examination shows this to be an even grained holocrystalline rock, whose original structure has been more or less defaced by a secondary parallel structure. It is made up of green hornblende, plagioclase, quartz, a little augite, and epidote and calcite, as secondary products. Some of the plagioclase occurs in tabular crystals, and these together with the hornblende suggest an ophitic structure.

The plagioclase is well twinned and the lamellae give a maximum extinction of about 30 deg., indicating labradorite. The augite is associated with hornblende. The quartz occurs in small, clear, lenticular grains. A few irregular patches of epidote and calcite were observed in the slide.

No. 18. (118a, 118b and 118c) Locality, Ragan's Old Mill, Lee county, Alabama.

Quartz-diorite.—This is a dark green, schistose rock, in which hornblende and feldspar can be distinguished megascopically.

Microscopically the chief constituents are seen to be green hornblende, plagioclase and quartz. The rock is holo-crystalline, and has a secondary parallel structure. Hornblende is the predominating mineral and it occurs in elongated allotriomorphic masses. The feldspar is the oldest constituent and it has a tendency to assume lath-shaped crystals. It is well twinned and the lamellae extinguish at about 30 deg. as a maximum, indicating a labradorite. The twinning according to albite law is frequently accompanied by both Karlsbad and pericline twinning.

Quartz occurs in irregular patches, much fractured and giving wavy extinction, and is probably a primary constituent of the rock. It is also present in larger masses, showing no cataclastic structures, and this is evidently a secondary constituent of the rock.

Hornblende Schists.

This embraces a series of schistose rocks, consisting chiefly of quartz and hornblende, with often some plagioclase, and usually some augite. They are probably alteration phases of diorites and quartz diorites.

No. 7. (106a and 106b) McDiarmid Old Place, near Brownsville, Clay county, Alabama.

Hornblende-schist.—Megascopically this rock is of dark green color. Crystals of green hornblende occur in an aphanitic ground mass.

Microscopic examination shows that the essential minerals of this rock are green hornblende, quartz, muscovite, and epidote. The hornblende occurs in irregularly bounded masses, scattered through a groundmass, consisting of quartz, muscovite and epidote.

The groundmass consists of lenticular quartz grains interwoven by shreds of muscovite. Epidote occurs as scattered grains and granular masses. Calcite occurs sparingly in small masses. It is interesting to note the presence of muscovite which was not observed in any other of these schists.

No. 10 (109a and 109b). Locality, two miles west of Idaho, Clay county, Ala.

Hornblende-schist.—Megascopically, this is a fine grained dark green rock. Prismatic crystals of hornblende can be distinguished, and smaller grains of quartz and feldspar.

Microscopic. A rock made up of pale green hornblende, augite, plagioclase and quartz. The hornblende occurs in elongated masses arranged parallel. Augite is associated with the hornblende. Plagioclase is not very plentiful, and occurs as tabular crystals. The feldspar shows multiple twinning, but the determination of it is unsatisfactory. Epidote is scattered through the rock in small grains. Quartz occurs in lenticular grains and seems to be entirely secondary.

No. 19 (119a and 119b). Locality, one mile south of Double Bridges Ferry, Elmore county, Ala.

Hornblende-schist.—Megascopically, this rock is of a dark green color, and has almost a slaty cleavage. When broken across the cleavage it is seen to be a finely banded crystalline schist. Dark bands of prismatic crystals of hornblende and chlorite alternate with light bands, composed chiefly of fine grains of quartz.

Microscopic. The thin section discloses green hornblende quartz and a little augite to be present. The hornblende occurs in prismatic crystals which have a rough parallelism and are partially altered to chlorite. The quartz occurs as irregular, interlocking grains. A few grains of augite were observed scattered through the section. Considerable magnetite is present in irregular shaped masses, and octahedral crystals.

Diabases.

Under this heading I have grouped diabases, quartz diabase, epidorite, and some schists which are plainly mechanically deformed phases of these rocks. The quartz diabase seems to predominate in the region, but we are here again involved in the difficulty of distinguishing between the primary and secondary quartz.

No. 13. (112a and 112b) Locality, two miles southeast of Fredonia, Chambers county, Ala.

Epidiorite.—Megascopically, this is a medium coarse grained rock, made up of dark green hornblende, white feldspar and quartz.

Examination of thin section shows the rock to be made up of hornblende, augite, plagioclase, quartz and epidote. The minerals are all arranged more or less parallel, and the original structure of the rock has been defaced. Except the plagioclase, which shows a tendency to crystallize in tabular form, the minerals are all allotriomorphic.

The hornblende is of a pale green color, and is plainly derived from the augite. The transition from augite to hornblende can be observed in the thin section.

The plagioclase, which is not very plentiful, shows albite twinning, but the determination is unsatisfactory. Quartz occurs as an alteration product in small irregular grains.

Epidote is the most plentiful mineral. It seems to be an alteration product of both the feldspar and the ferromagnesian silicates.

No. 11. (110a and 110b) Locality, near Louina, Randolph county, Ala.

Diabase-schist.—Megascopically a finely banded rock. Dark bands of green hornblende alternate with light colored bands of pink feldspar.

Microscopic examination shows this rock to be made up of pale green hornblende, plagioclase, with a little quartz and augite. The original structure of the rock has been entirely destroyed by the mechanical deformation. The hornblende occurs in irregular elongated masses, having a rough parallelism. The augite is closely associated with hornblende.

The plagioclase occurs in patches of mosaic intergrowths, which are probably formed by secondary recrystallization of the feldspar. With it is associated a little quartz. The albite twinning is rather inconspicuous, and the determination of the feldspar unsatisfactory, but it probably belongs near the basic end of the lime-soda-feldspar series. Epidote is scattered through the rock in small grains.

No. 12. (111a and 111b) Locality, one and one-fourth miles north of Fredonia, Chambers county, Alabama.

Quartz-diabase.—Megascopically this is a dark green holocrystalline rock. Dark green hornblende, white feldspar and glassy quartz can be distinguished in hand specimens.

A microscopic examination reveals a rock with partially defaced ophitic structure, consisting of hornblende, plagioclase and quartz. The rock has a parallel structure induced by the mechanical deformation. The plagioclase exhibits a tendency to form tabular crystals. The lamellæ give a maximum extinction of about 40 degrees, indicating a basic labradorite. The hornblende occurs in irregular allotriomorphic masses, which often enclose the feldspar crystals. The hornblende is dark green, and shows an extinction of about 20 deg. The hornblende is partly altered to chlorite. Quartz occurs in irregular grains, which, like the feldspar, are cataclastic. Small grains of epidote are scattered through the rock.

No. 8. (102a) Locality, Oakfuskee, Riddle's Bridge, Alabama.

Quartz-diabase-schist.—Microscopic.* In thin section of this is seen to be a holocrystalline rock, in which a secondary foliation has been produced by mechanical deformation. It consists essentially of pale green hornblende (partially altered to chlorite), plagioclase, quartz, which is probably mostly secondary, with a little augite and zoisite.

The feldspar, which is probably anorthite, occurs in broken and partially replaced crystals, which were originally tabular. The hornblende occurs in irregular masses elongated parallel to the foliation. The original structure of rock was evidently ophitic.

Quartz occurs in small irregular patches all through the slide, often replacing in part the plagioclase crystals. Much of the quartz is fissured and gives wavy extinction. If this cataclastic quartz is secondary, it must have been formed previous to the mechanical deformation of the rock. The zoisite occurs as granules and prisms all through the rock. Epidote occurs sparingly in slide as small granular masses and scattered grains.

Pyroxenites.

The two rocks under this heading are characterized by the entire absence of feldspar and quartz. One of them is plainly a partly altered and squeezed pyroxenite. The other, which I have called an amphibolite, is made up chiefly of uralite, which is probably paramorphic after augite.

No. 9. (108a and 108b) Locality, Sec. 1, T. 24, R. 20 E., near Goodwater, Coosa county, Ala.

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*Hand specimen of this rock was lost.

Pyroxene-epidote-schist.—Megascopically, this is a pale green rock, on the fresh fracture of which the glittering surfaces of crystal faces can be seen. These crystals are of a light green color, and are contained in similarly colored groundmass.

Under the microscope the rock is seen to consist of pyroxene partly altered to epidote. In the slide no definite crystalline outline can, as a rule, be made out, but it seems to have originally been an intergrowth of prismatic crystals.

No. 8. (107a and 107b) Locality, D. C. Carmichael, near Brownsville, Clay county, Ala.

Amphibolite.—Megascopically, the rock is of light green color, and much resembles the chlorite schists previously described. The examination of thin section shows it to consist essentially of a holocrystalline intergrowth of a pale green hornblende. A little augite occurs with hornblende. Some of ths hornblende has been altered to chlorite. Quartz and feldspar are entirely wanting in this rock.

Chlorite and Epidote Schists.

This group includes all the most highly altered basic rocks of the region. Megascopically they are soft greenish rocks which often have a slaty cleavage, and can easily be mistaken for clastics. The microscopic study of a series of specimens of the schists show them to be of undoubted igneous nature. They are usually found to contain some secondary quartz, and often contain remnants of a feldspathic constituent. They are probably derived from the diorites and diabases, and from the most basic rocks.

No. 4. (103a and 103b) Locality, three-fourths miles southwest of Chandler Springs, Talladega county, Alabama.

Chlorite schist.—Megascopically, this is an aphanitic rock, having a light green color and an imperfect cleavage.

Microscopic. In thin section the microscope discloses a rock made up of hornblende, chlorite and zoisite. The chlorite occurs as plates with irregular outline, and as fibrous masses. The zoisite occurs as granules and prisms. A few grains of quartz were observed in section. The hornblende is pale green, and occurs in small fibrous masses.

No. 5. (104a and 104b) Locality, one mile south of Coleta, Clay county, Alabama.

Chlorite-epidote-schist.—Megascopically, the rock is of a light green color. Rounded phenocrysts of quartz and feldspar (chiefly quartz) are seen enclosed in a groundmass of light green color.

The microscopic examination shows it to be a highly metamorphosed rock, made up almost entirely of secondary minerals. It consists essentially of quartz, epidote, chlorite and zoisite.

Tabular crystals of what were once phenocrysts of feldspar are scattered through the rock. In several of these phenocrysts a little of the polysynthetic twinning feldspar was observed, but for the most part the feldspars have been entirely replaced by mosaics of interlocking quartz grains, or by aggregations of quartz, epidote and zoisite.

The groundmass of the rock consists of an aggregation of epidote, chlorite, zoisite and quartz. The chlorite occurs in irregular stringers, and the epidote usually intergrown with zoisite. Less frequently epidote occurs as separate masses and filling cleavage cracks. The epidote and zoisite seems to be secondary after augite, for a few unaltered augite grains were included in these aggregations of secondary minerals.

The quartz occurs as mosaics with irregular boundaries, and as small veins, cutting all the other minerals. There seems to have been an infiltration of quartz after the foliation of the rock. This would make two generations of quartz. First, that formed during the metamorphism of the rock, and second, that of secondary infiltrations after the foliation of the rock. There is also the possibility that the rock contained some primary quartz. The plagioclase feldspar noted above is probably the only primary constituent which the rock now contains. The rock is probably an altered diabase, which has been subjected to extreme metamorphism.

No. 6. (105a and 105b) Locality, Brownsville, Clay county, Ala.

Chlorite-epidote-schist.—Megascopically, this rock is of a light green color and of fine texture. The mass of the rock is made up of soft green mineral. Small flakes of muscovite are scattered through it.

Microscopic examination shows it to be a fine grained, foliated rock, consisting essentially of quartz, chlorite and epidote. Quartz occurs in lenticular grains which have a wavy extinction. Chlorite occurs in fibrous aggregates, arranged more or less parallelly, giving the rock imperfect cleavage.

Epidote is intimately associated with chlorite as grains and granular masses. Several irregular shaped masses of calcite were observed, and also a little zoisite associated with epidote. The rock also contains considerable muscovite in small plates.

It is interesting to note that section No. 105a contained one irregular mass of magnetite, for there is striking absence of that mineral in most of these rocks.

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GEOLOGICAL SURVEY
OF
ALABAMA,

EUGENE ALLEN SMITH, Ph. D., State Geologist.

BULLETIN No. 6.

PRELIMINARY REPORT
ON THE
CLAYS OF ALABAMA,

BY

HEINRICH RIES, Ph. D.

THE VANCE PRINTING CO., STATE PRINTERS AND BINDERS,
JACKSONVILLE, FLA.
1900.

To His Excellency,
JOSEPH F. JOHNSTON,
Governor of Alabama.

DEAR SIR:—I have the honor to submit herewith, as part of my biennial report, 1898-9, a report upon the clays of Alabama by Dr. Heinrich Ries. While the investigations of Dr. Ries here recorded have been confined to the northern half of the State, and mainly to one or two formations, they yet embrace the most important and most accessible of our clay deposits. The kaolins of the granite region lie at a distance from railroad lines, and the discussion of these and of the clays of the more recent formations, in the lower half of the State, will be taken up in a second bulletin.

The present report shows that our clay resources include every variety, ranging from the best of china clays downward, and there seems to be no good reason why all these materials should not be turned into the manufactured products, chinaware, stoneware, fire brick, ornamental brick, paving brick, tiles, drain pipes, etc., within our own borders and upon our own ground.

Very Respectfully,
EUGENE A. SMITH.

University of Alabama,
March 15, 1900.

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PREFACE.

Clay is one of the most abundant materials found in the earth's crust, and occurring as it does in every country, in almost every geological formation from nearly the oldest to the youngest, and frequently in positions easy of access, it is not to be wondered at that these conditions, aided by the peculiar properties which it possesses, have caused this material to become one of the most useful and valuable products of the earth.

The value of clay is still more readily understood when the statistics of its production are known. Thus in 1897, the total value of clay products made in the United States alone was $60,911,641.00, distributed as follows:

Common brick	$ 26,353,904
Pressed brick	3,931,336
Vitrified paving brick	3,582,037
Ornamental brick	685,048
Fire brick	4,094,704
Drain tile	2,623,305
Sewer pipe	4,060,534
Terra cotta	1,701,422
Fire proofing	1,979,259
Tile other than drain	1,026,398
Miscellaneous	1,413,835
Pottery	9,450,859

Up to the present time the rank of Alabama as a clay producing state has not been very high, owing largely to the lack of information concerning its clay resources, and in the following report an endeavor has been made to furnish as much information as possible concerning the characters of many of the Alabama clays.

HEINRICH RIES.

March 1, 1900.

I

GENERAL DISCUSSION OF CLAYS,

By Heinrich Ries.

ORIGIN OF CLAY.

Clay is to be met almost every where, and while it varies in form, color and other physicial properties, nevertheless it always forms a pasty or plastic mass when mixed with water, by virtue of which it may be molded into any shape, which it retains when dried; furthermore when exposed to a high temperature it hardens to a rock like mass. These two properties, the plasticity and the hardening when burnt are what make clay of such inestimable value to man.

Pure clay or kaolin is composed entirely of the mineral kaolinite, which is a hydrated silicate of alumina. It rarely happens, however, that clay is perfectly pure, for owing to the nature of its formation from another rock as will be explained later, it is very apt to have other minerals mixed in with it. These foreign minerals may sometimes be present in such quantities as to completely mask the character of the kaolinite.

We can therefore define clay as a mixtureof kaolinite with more or less quartz and other mineral fragments, especially feldspar and mica, the whole possessing plasticity when mixed with water, and becoming hard when burned.

The so called flint clays form an exception to the above, for while they often approach pure kaolin in composition, still they are almost devoid of plasticity when ground and mixed with water.

Kaolinite is a secondary mineral resulting from the decomposition of feldspar. The feldspars are a group of silicate minerals of rather complex composition, with orthoclase, the potash feldspar, serving as the type of the group, as well as being the commonest species.

Under the influence of chemical action, which may be the result of weathering or in some cases probably of acid vapors ascendning from the interior of the earth, the feldspar becomes decomposed, and the result of this is that the potash of the feldspar is removed partly in the form of solube carbonate, or perhaps silicate, or even fluoride, while the alumina and silica remain and unite with water to form the hydrated silicate of alumina, kaolinite, whose composition is expressed by the formula Al_2 O_3, $2SIO_2$, $2H_2O$., or in the proportion of silica, 47.30 per cent.; alumina, 39.80 per cent.; water 13.90 per cent.

The change can be illustrated still better by the following in which the first column indicates the composition of the feldspar, the second the amount of water taken up in the process of decomposition, the third, the amount of matter removed in solution, and the fourth the relative amounts of the three ingredients of kaolinite.

	Feldspar.	Added.	Dissolved out.	Kaolinite.
Alumina....	18.3	....	0.0	18.3
Silica....	64.8	....	41.8	23.0
Potash....	16.9	....	16.9	....
Water.....	....	6.4	....	6.4

Many clays approach quite closely to kaolinite in their composition, and in some the percentage of alumina even exceeds the theoretic amount, by one or two per cent., and is evidently not due to errors of analysis.

It has been suggested by some that this may be due to the presence of a certain amount of *pholdrite,* the amorphous variety of kaolin,* and while this is possible the same composition might be shown by a certain amount of bauxite or alumina hydrate mixed in with the clay.

---

* Wheeler, Clays of Missouri, Missouri Geological Survey, XI.

None of the Alabama clays thus far analyzed indicate this exceptional composition.

Knowing the mode of origin of kaolinite it will at once be seen that the purity of the kaolin depends on the nature of the parent rock. Feldspar often forms large veins of considerable purity, and nearly free from other associated minerals, and its decomposition in such cases would give rise to deposits of pure or nearly pure kaolin. In point of fact the purest clays known have with few exceptions been formed in this manner. More frequently quartz and mica are common accessory minerals, and remain intermixed with the kaolinite, both of them being more resistent to weathering than the feldspar. When these or other minerals occur in the kaolin they have to be separated from it as much as possible by washing.

Clays, which occur at or close to the locality in which they have been formed, are called "residual clays". They represent some of the purest types of clay known as well as the most impure. The upland region of the Southern States is underlain by a great area of feldspathic, granitic and gneissic rocks which have decomposed to a ferruginous clay of residual nature, and one that is used extensively in the South for the manufacture of common brick.

In the general wearing down of the land surface which is continually taking place the particles of residual clay are washed down into the lakes and oceans and deposited there as sediments, thus giving rise to what are known as sedimentary clays. They are usually far more plastic than the residual clays, especially the purer ones.

From the nature of their formation, we should seldom look for kaolins of sedimentary origin, and when they do occur they have probably been derived from large areas of very feldspathic rock or possibly from limestones which had an appreciable percentage of silicate of alumina in their composition, in which case the lime carborate would be carried off in solution, and the clay components of the rock be left behind as an insoluble residue. It is seldom that sedimentary clays exhibit such remarkale purity as those from Chalk Bluff, Alabama, or the plastic ball clays of Florida.

The clays of the Cretaceous and Tertiary formations, which underlie the Coastal Plain, as well as the Palaeozoic shales found in Alabama, are all of sedimentary origin.

GEOLOGICAL STRUCTURE AND DISTRIBUTION OF CLAY DEPOSITS.

RESIDUAL CLAYS.

The mode of origin of these has already been explained. They may occur either in the form of a broad mantle overlying the bed rock and showing a variable thickness as well as extent, or they may occupy the position of a vein cutting across the strike of the other rocks, or extending at times with the bedding or lamination of them.

Residual clays are commonly made up of a mixture of angular grains which are chiefly undecomposed mineral matter, and clay particles which are mostly of sufficient fineness to remain suspended in water for an almost indefinite period. There is also generally a gradual transition from the fully formed clay at the surface to the fresh rock below, whose decomposition has given rise to the plastic mass above.

The depth below the surface at which the unaltered rock is encountered may be as little as three to four feet, while in some regions where the surface has been little eroded, and decomposition has been active, the thickness of the residual clay may exceed one hundred feet.

The structure of the parent rock such as stratification or lamination is at times often noticeable in the lower portion of the residual deposits, and in some cases it may even be preserved right up to the surface.

Residual deposits of the vein type result commonly from the decomposition of veins of granite or feldspar. They vary in width, from a few inches to several hundred feet, and their vertical extent depends in most cases on the depth to which the weathering action has progressed.

Veins of kaolin seldom show great length, and when followed along the surface not uncommonly pinch out in both directions. They are often separated more or less sharply from the country rock, and this distinct line of demarkation is preserved even when the wall rock itself is decomposed. They furthermore frequently branch and at times contain lenses of quartz, which resist the weathering agencies and stand out in bold relief on the surface. It rarely pays to work a vein under six feet in width.

Deposits of kaolin of the type just described should not be confused with sedimentary deposits of white clay, which are usually of a much greater extent than the vein formation.

SEDIMENTARY CLAYS.

These occur in the form of beds, which are either close to the surface or interstratified with other deposits which have been accumulated in water, such as sandstone or limestone. They are not unfrequently interbedded with coal deposits and many a coal seam has a fire clay floor. Sedimentary clays are, as a rule more homeogeneous than residual ones, and contain probably a greater portion of fine particles. They are also more plastic, and frequently contain much disseminated organic matter. Furthermore, they do not pass gradually into the underlying rock as residual clays do, and indeed bear no relation, in a genetic sense, to the rocks upon which they rest.

When sedimentary clays become compressed by the weight of overlying sediments, they assume the character of hard or consolidated rock, and are known as shale. Shales therefore simply represent the finest clay sediment which has bcome consolidated.

On grinding to a powder and mixing with water, shales become just as plastic as other clays. By mentamorphism, (that is heat and pressure developed by mountain making processes) taking place in the crust of the earth, a shale may lose its chemically combined water, develop a cleavage, and become converted into slate. It is then no longer possible to develop any plasticity in the material.

It is not to be understood that all sedimentary clays are of a homogeneous structure throughout. Some beds may exhibit a wonderful similarity of composition throughout extended areas, while again there may be a wide variation in the character of any bed within narrow limits. Apart from this variation laterally, there may also be a vertical one in cases where the deposit is made up of a number of beds, one over the other, each showing distinctive characters. With such occurrences it is possible to obtain several different grades of clay from the same pit. Such conditions are apt to be the rule rather than the exception.

A not uncommon phenomon in many of the coastal plain formations is the occurrence of large lenses of clay, free from grit surrounded by beds of sandy clay or even sand.

DISTRIBUTION.

Clays and shales occur in practically every geological formation with the exception of the oldest. Most of those which are older than the Createceous are hard and shale—like in their nature, while those of the Cretaceous and Tertiary on the other hand are usually soft and plastic, but deposits of Createceous and also Tertiary shales are known.

The geological age of a clay or shale is no indication of its quality, and it is only of use at times for a means of comparison between two beds situated near each other, but even here it is not altogether a safe guide.

The geological relations of the clays of Alabama are treated somewhat more in detail below in a separate chapter.

PROPERTIES OF CLAYS.

These fall into two classes, i. e. (1) Chemical and (2) Physical. Two clays may correspond in their widely in their physical characters, and therefore act entirely opposite when used for the manufacture of clay products.

Pure clay or *kaolin* would be composed entirely of *kaolinite*, the hydrated cilicate of alumina. These two terms are often confounded and it is well to empahasize the fact that kaolinite refers to the mineral species, while the term kaolin is applied to the mass. Pure kaolin has not thus far been found, although deposits containing as much as 98 per cent. of it are known, and the other two per cent. consists of foreign matter. The kaolin therefore contains a variable amount of mineral impurities mixed in with the kaolinite or the clay substance, as it is some times called, and these impurities may affect both the chemical and the physical properties to a variable extent, depending upon the quantity and the kind of them present. The clay substance is always present but in a variable amount, and it stands in no direct relation to the plasticity, except in so far that the latter is lost when the combined water is driven off.

The amount of clay substance in clays ranges from 5 or 10 per cent. to 98.5 per cent.

The chief impurities in kaolin are quartz, feldspar and mica, but in other clays the number of mineral species present may indeed be large.

CHEMICAL PROPERTIES.

The chemical composition of a clay directly influences its fusibility, and the color to which it burns.

The compounds which may be found in clay are silica, alumina, iron oxide, lime, magnesia, potash, soda, sulphuric acid, phosphoric acid, manganese oxide and organic matter. Compounds of chromium and vanadium may also be present at times in small amounts. All of these substances are not present in every clay, but most of them are.

Pure clay would contain silica, alumina and combined water, but the purest clay known commonly contain at least traces of iron oxide, lime and alkalies.

Alumina, organic matter and water are practically the only non-volatile constituents, which do not exert a fluxing action on the clay in burning, and the intensity of this fluxing depends partly on the amount of fluxes, and partly on the temperature at which the clay is burned.

It is the custom to divide the impurities of clay into those which are fluxing, and those which are non-fluxing.

Pure clay is very refractory. The kaolinite composing it contains two molecules of silica and one molecule of alumina. A higher percentage of silica tends to increase the fusibility up to a certain point, provided it is in a finely divided condition. above this point the refractoriness of the clay increases steadily with the addition of silica.

Other substances are far more powerful fluxes than the silica however, and these fluxes contain not only elements but also definite chemical compounds or mineral species.

The influence of fluxes increases not only with the amount present but also with the state of division, they being more active, the more finely they are divided. If the fluxing material is present in large grains, these will only exert a fluxing action on their upper surface, while the single grains alone will for a while act more like quartz grains i. e. as diluents of the shrinkage. The minerals which may be present and serve as fusible impurities are commonly mica, feldspar, hornblende, pyroxene, garnet, quartz, calcite, gypsum, iron oxide and manganese, and the elements contained in these constituting the active fluxing agents are alkalies, iron oxide, lime and magnesia.

Opinions differ somewhat in regard to the order of their relative effectiveness, but it is probably given above, the alkalies being the strongest.

The amount and kind of fluxes which it is desirable for a clay to contain depends on the use to which it is to be put. If a vitrified ware is desired then the fluxes should be present in appreciable amount, say 10 to 20 per cent., depending upon the relative strength of the fluxing impurity. Refractory clays, on the other hand, should contain a low amount of fusible substances. Porcelain clays might have as high a percentage of fluxes as 5 or 6 per cent., provided they did not exert a coloring action on the clay.

ALKALIES IN CLAYS.

The alkalies usually contained in clays are potash, soda and ammonia.

Ammonia is a very common constituent of moist clay and is absorbed by the latter with great avidity; indeed it is largely responsible for the characteristic oder of clay.*

If the ammonia remained in the clay, it would act as a strong flux. but its volatile nature renders it harmless, for it passes off as a vapour at a temperature considerably below dull redness, and in fact may even volitilize with the moisture of the clay during the early stages of burning.

Potash and soda on the other hand, which volatilize only at a high temperature, are present in almost every clay from the smallest amount up to 9 or 10 per cent. and of these potash is by far the commoner of the two. Their variable percentage may be caused by the presence of more or less undecomposed feldspar, of which orthoclase, the common species. has nearly 17 per cent. of potash while the other feldspars contain varying amounts of soda.

These alkalies may be present in the clay in the form of either soluble or insoluble compounds, the latter being represented by feldspar, mica, or other minerals, while the soluble ones are usually the result of their decomposition.

Soluble alkaline compounds may be found in almost any clay. but they are rarely present in large amounts, and their chief importance lies in the fact that they are often responsible for the formation of an efflorescence or white coating on the surface of the ware, they having become concentrated on the surface by the evaporation of the moisture of the clay. They may be rendered insoluble by the addition of chemicals to the clay. In addition to its unsightliness the efflorescence may interfere with the adhesion of a glaze applied to the surface of the ware.

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*F. Senft, Die Thon Substanzen, p. 29.

Soluble alkaline sulphates are powerful fluxes and they also cause blistering of the ware, if the clay is heated sufficiently high to decompose the compound and permit the escape of sulphuric acid gases.

In some clays containing sulphate of iron, this compound may be decomposed by chemical reaction taking place in the clay; the sulphuric acid, which is thus set free, is apt to attack the alumina of the clay substance and if potash, soda, or ammonia is present there is formed an alum of potash, soda or ammonia, which can often be detected by the taste which it imparts to the clay.

Insoluble alkaline compounds. Feldspar and mica which are the commonest of rock forming minerals are the two important sources of insoluble alkaline salts in the clay.

The feldspars are complex silicates of alumina and potash, or alumina, lime and soda. Orthoclase is the only species furnishing potash and contains about 17 per cent. of it while the lime-soda feldspars have from 4 to 14 per cent. of soda depending on the species.

Orthoclase is the common feldspar, and next to it come albite and oligoclase with 12 and 14 per cent. of soda respectively.

The micas are complex silicates of alumina with either lime or magnesia or potash. Muscovite, the common species, contains nearly 12 per cent. of potash, and may at times also contain soda. While the potash feldspar fuses completely at about 2300° Fahr., the potash mica alone is very refractory and unaffected by a temperature of 2550° Fahr., and though it probably serves as a flux, it is not definitely known at just what temperature its action begins.

The alkaline silicates on account of their fluxing properties are frequently at an advantage, especially if in the form of feldspar, as they serve in burning to bring the particles of the clay together into the dense hard body, and also permit of the ware being burned at a lower temperature. If present in kaolins to the extent of several per cent. it is no detriment, provided no iron is present; an excess of feldspar, however, when added to a white burning clay will tend to produce a creamy tint.

In the manufacture of porcelain, white earthenware, encaustic tiles and other products made from kaolins or white burning clays, and having a white body, which is impervious, or nearly so, the alkalies for the fluxing of this body are added in the form of feldspar.

Much feldspar is mined in this country for potters use, but all of it is the ortholase or potash feldspar.

IRON COMPOUNDS IN CLAYS.

Iron is not simply a fluxing impurity, but it is also the great coloring agent of clays in either their burned or unburned condition, and furthermore when in the form of the hydrated oxide or limonite it may serve to increase the absorbtive power of clay. *

The compounds in which iron may exist in the clays are as follows: Oxides:—limonite, hematite, magnetite, ilmenite. Silicates:—mica, hornblende, garnet, etc. Sulphides:—pyrite and marcasite. Sulphate:—melanterite. Carbonate:—siderite.

The iron oxides, limonite and hematite, are present in all clays, and may be introduced by percolating waters or be set free by the deccomposition of any of the iron-bearing silicates which the clay may contain. Not infrequently they are distributed through the clay in a very finely divided condition, or may form a thin film around the other mineral grains. Limonite tends to color the clay (unburned) brown or yellow, while hematite imparts a red color to it, and carbonate of iron may give gray tints.

The more sandy the clay the less the amount of the

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* A. E. Smith, Alabama Geological Survey, Agricultural Report, p. 45.

limonite required to produce any given intensity of color.

Mica is found in most clays, and hornblende and garnet are probably wanting in few, while the pyrite is often present in many clays, especially in stoneware and fire clays, its yellow, glittering, metallic particles being easily recognizable. When large, the lumps of pyrite can be extracted by hand-picking, but if very small, they can only be separated by washing. Under weathering influences the pyrite changes to sulphate of iron. In all of the iron-bearing minerals the iron is present in either the ferrous or the ferric stage of oxidization, and the fusibility of the clay is influenced somewhat by this fact, for ferrous compounds are more easily fusible than ferric ones. In the burning of the clay the ferrous salt will be converted into the ferric state, provided the action of the fire is oxidizing. But if it is reducing the clay will fuse at a lower temperature.

The action of weathering agent in nature is often sufficient to oxidize the iron in clays so that more ferric than ferrous iron will be found in most of them. This change is often noticeable in many clay banks where the upper, and at times more porous layers, are colored red or yellow, while the lower layers are blue or bluish gray.

It should be noticed, however, that a gray color may be produced by the presencce of organic matter, and the same material present in a dense clay, to which the air can not get access, may serve to retard the oxidation of the iron. Whenever iron exists in clay in combination with silica it is present probably as a complex silicate, for pure ferric silicate is very rare in nature.

Ferric hydrate increases the absorbing power of clay for both gases and liquids, but it as well as the carbonate change to the oxide in burning.

The general tendency in burning is to convert the iron compounds into ferric oxides, provided a certain temperature, depending on the fusibility of the clay, is not exceeded, for in every clay the iron seems to return to the ferrous condition as the point of vitrification is approached. This change is accompanied by a liberation of oxygen, which is responsible for the active swelling and blistering of the clay, which takes place as the point of viscosity is approached.

If treated to an oxidizing fire, the presence of ferrous salts in clay may not be considered, provided the heat is raised high enough to oxidize them, but the rapidity with which the temperature is raised is important, for when the heat is increased rapidly the outer portion of the clay tends to shrink and become dense before the air has had time to enter and oxidize the iron in the center of the clay body, the latter remaining in ferrous state. This is the cause of black cores sometimes seen in bricks whose exterior is red.

Unburned clay may be yellow, blue, brown, red or gray in color, depending on the relative amount of ferrous and ferric salts present, for iron is the one element above all others which by itslf colors clays.

The same variety of shades and colors may be produced in burning. Ferrous oxide alone produces a green color when burned while ferric oxide alone may give red or purple, and mixtures of the two may produce yellow, cherry red, violet, blue and black.[*]

Segar found that combinations of ferric oxide with silica had a red or yellow color[§] while similar compounds of the ferrous salts showed blue or green.

The color to which any given clay burns may also depend on the intensity of the firing. Thus with moderate burning the iron may color a clay yellow or yellowish red, with harder firing this will pass into deep red, and on still more intense heating to blue or black, this latter color is to be seen on breaking open the arch brick in many kilns, but the surface of these same brick may also get black, due to ashes and cinders from the fire sticking to them.

The amount of ferric oxide permissible or desirable depends on the use to which the clay is to be put.

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[*] Keramik, p. 256.

[§] Notizblatt, 1874, p. 16.

The clays which are used for making white ware should not contain over one per cent ferric oxide. And those with even three-quarters of one per cent are apt to burn grayish at a high temperature, such as 2700 deg. Fahr. It is true that the reddish coloration of a small percentage of iron would be neutralized if any excess of carbonate of lime were present, but in this case even we should not get a pure white tint, but a yellowish one.

Brick clays should contain sufficient iron oxide to give a good red color to the ware when burned.

The bleaching of the iron coloration by the presence of lime will be mentioned later, an excess of alumina also tends to exert a decolorizing action upon the iron contained in the clay.

LIME IN CLAYS.

Lime is a most wide-spread constituent of clays, and occurs either in a finely divided state or else in the form of pebbles. An excess of lime in the clay in the former condition causes it to pass into marl, and in certain regions such clays are extremely abundant.

Lme may occur in clays either as a constituent of *silicate* minerals such as feldspar; in the form of *carbonate* as exampled by calcite or dolomite; or thirdly it may be present as a *sulphate*, which is the mineral gypsum.

The first two classes of compounds include minerals which are primary constituents of the clay, but the third type, gypsum, is usually of secondary origin, being the result of chemical processes, which took place in the clay mass.

The condition of lime is important, for in one case, it may be desirable, and in another it may do injury.

The presence of lime as a constituent of some silicate mineral is not infrequent, especially if the clay has been derived wholly or in part from crystalline rocks, such as gneisses and granites. The common feldspar, orthoclase, contains no lime, but the other species of feldspar do, and in addition there are other lime bearing silicates which are apt to be met with in most of the impure clays.

When present as a silicate, lime acts as a flux, and is less liable to exert a decolorizing action on the clay than carbonate of lime. Bleaching action is caused by the formation of a double silicate of iron and lime, when the clay reaches a temperature approaching vitrification, and the color developed is either yellow, or yellowish green, according to the intensity of the firing.

Carborate of lime is an abundant constituent of some clays, and its presence, if over three or four per cent., can usually be detected by the effervescence which is producd when muriatic acid is poured on the clay. This compound of lime is far more injurious than the silicate, although, if present in the clay, in a finely divided condition, it may not only be harmless but even desirable, provided there is not an excess of it, for clays with as much as twenty to twenty-five per cent. of lime carbonate have been used for making common or even pressed brick and somtimes earthenware. It is well, however, to try and keep the amount lower than this if possible. Highly calcareous clays have often found a use in making of slip glazes.

If the carbonate of lime is present in the form of pebbles, a most undesirable effect is produced, for it is well known that when heated to redness, the compound is broken up into oxide of lime and carbonic acid gas; this oxide of lime, when cooled, absorbs moisture from the atmosphere and slakes, the result being a swelling of the material and a consequent splitting of the brick. Now if the clay be heated to a temperature sufficent to decompose the carbonate of lime, but not high enough to make it unite with any free silica present, the lime of course slakes on cooling. It is consequently imporatnt either to burn the clay sufficently or remove the lime pebbles from the clay by screening or by some other method before using.

For a high grade ware, calcareous clays are seldom employed, but in the manufacture of brick and terra-cotta, they are frequently utilized either because no others are available or to obtain a buff colored ware.

Some soft body porcelains have an appreciable amount of lime, much of the Hungarian containing from five to fifteen per cent. of CaO.* The bone china made in England at the present day also contains lime and some white earthen ware manufacturers use lime instead of feldspar.

Much buff ware is now made from semirefractory clays, which, on account of their low percentage of iron, burn to a creamy color.

The one objection to highly calcaeous clays is that the points of incipient fusion and vitrification (see Fusibility of Clays) lie so close together that it is not safe to burn them hard without running the risk of fusing them. Experiments have shown however, that it is possible to separate these two points, by the addition of quartz and feldspar to the clay, of sand containing a large percentage of these two minerals.

In addtion to lowering the fusibility of clay, lime also affects the fusion and absorptive power, thus Segar found§§ that limy or marly clays required usually only twenty to twenty-four of water to convert them from a dry condition to a workable mass, whereas other clays needed twenty-eight to thirty per cent. of water to accomplish the same result. In burning the calcareous clays have not only their combined water to lose, but also the carbonic acid gas, and consequently the bricks are more apt to be light and porous unless they can be burned to vitrification. The shrinkage of calcareous clays is also less than that of others, and it sometimes happens that this shrinkage is not only zero, but that the brick even swells.

Many clays contain lime in the form of gypsum, the hydrated sulphate of lime. It generally results from the action, on carbonate of lime, of sulphuric acid set free by the oxidation and leaching of pyrite in the clay.

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*Sprechsaal, 1896, p. 2.

§ Hecht, Thonindustrie Zietung.

§§ Thonindustrie Zietung, 1877, p. 131.

When in large amounts, gypsum discloses its presence by the formation of transparent crystals or crystalline masses, whose surface shows a pearly lustre; at other times it forms as parallel fibres which fill cavities or cracks in the clay. Gypsum may prove to be a very injurious impurity even when in small amounts, especially if the clay is not burned to vitrification.

In the first place it serves as a fluxing impurity, secondly, it is dissociated at high temperatures, and the escape of the sulphuric acid causes blistering of the ware, and thirdly, although nearly insoluble in water, nevertheless small amount of it may be brought to the surface of the ware in solution by the evaporation of water and there left in the form of a white coating.

Kaolins commonly have very little lime, but in many common brick and stone ware clays, it frequently ranges from one to three per cent.

MAGNESIA IN CLAYS.

Magnesia is a constituent of many minerals, and yet it seldom occurs in large quantities, the amount in most of them rarely exceeding two per cent.

It may occur in the same classes of compound as lime i. e. *silicates,* such as mica, chlorite, hornblende and pyroxene; in *carbonates,* such as dolomite and magnesite; and in *sulphates,* such as epsom salts.

The silicates are, no doubt, the most important source of magnesia, for mica, chlorite, and hornblende are all common constituents of the more impure clays. They are scaly minerals of complex composition and contain from 1 to 25 per cent. of magnesia. The mica is frequently to be noticed in the sandy seams of the clay, while the other portions of the deposit may be quite free from it. Hornblende and pyroxene are to be looked for mostly in clays derived from the dark colored igneous rocks, and indeed the two latter minerals not only furnish magnesia, but by their decomposition furnish also iron oxide to the clay.

Dolomite, the double carbonate of lime and magnesia, may be present in some clays derived from ma nesian limestone, while the sulphate of magnesia o epsom salts when present, may aid in the formatio of a white coating on the surface of the ware; its pr sence can sometimes be detected by the bitter tast which it imparts to the clay.

The effects of magnesia in clays are considered to b the same as those produced by lime.

SILICA IN CLAYS.

Three types of silica may be recognized in clay, i. e

1st. Quartz.

2nd. That which is combined with alumina an water in kaolinite.

3rd. That which is combined with one or mor bases, forming silicate minerals, such as feldspar mica, etc.

In chemical analysis the first and third are sometimes grouped together under the name of sand, or a times erroneously spoken of as free silica.

The sand is practically insoluble in sulphuric aci and caustic soda and this fact is utilized in the rational analysis of clay.

Few clays, so far as known, are free from quartz but it is present in variable amounts in different ones A minimum of .2 of one per cent. has been recorde from New Jersey* while the average in the Woodbridge fire clays is five per cent.

In the Missouri flint clays, a minimum of .5 of on per cent., is recorded, while the sand percentage is 2 to 43 per cent. in the St. Louis fire clays, and 20 to 5 per cent. in the Loess clays.§

27 samples of Alabama clays contained from 5 to 5 per cent. of insoluble residue.

70 North Carolina clays had from 15.75 per cent to 70.43 per cent. of insoluble residue.

In European clays similar variations are observable. The most important effect of silica or sand is that as it increases the plasticity, tensile strength, and air shrinkage tend to decrease. In fact silica especially if present abundantly in large grains, may cause an expansion of the clay in burning.

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*G. H. Cook, Clays of New Jersey, 1878, p. 273.

§ Wheeler, Missouri Geological Survey, XI, page 54.

Quartz serves as a flux at very high temperatures, but at lower ones it tends to increase the refractoriness of the clay, and this property is governed some what by the size of the quartz grains and the amount of fluxing material which will fuse at lower temperatures.

Sand acts as a diluent of the shrinkage in air drying and also in burning up to a certain point depending upon the fusiblity of the constituent grain.

In the burning of low grade clay, the quartz grains tend to act as a skeleton and preserve the form of the mass,. while the fluxing impurity by their fusion bind the whole together.

TITANIC ACID IN CLAYS.

Titanium generally occurs in clays in the form of the mineral rutile (titanic oxide). It has always been looked upon as a rare element and a non-detrimental impurity, but the idea of its rarity has probably resulted from the fact that it is not commonly determined or looked for in the ordinary quantitative analysis. Its effect on the fusibility of clay has never been thoroughly understood, although it has seemed probable that its action was somewhat analogous to that of silica.

The experiments of Seger have indicated that when a hundred parts of kaolin and 6.65 per cent. titanic oxide were heated to above melting point of wrought iron, the resulting mass was densely sintered, and showed a dark blue fracture.

13.3 per cent. added to a hundred parts of kaolin gave a deep blue enamel at the same temperature, while an equal amount of kaolin with the addition of 10 per cent. of silica burned to a snow white mass at the same temperature and did not fuse. From this it will be seen that the actions of titanium and silica at high temperatures are not exactly alike.

ORGANIC MATTER IN CLAYS.

Organic matter affects not only the color of clay bu also its plasticity, absorptive power and tensil strength.

It is present in clays either in the form of finel divided pieces of plant tissue or larger fragments o stems or leaves, which settled in the clay during it deposition, and have since become wholly or partl converted into lignite. All surface clays contai plant roots, but these exert little effect other than t aid the percolation of surface waters.

Clays colored by organic matter and containing n iron, burn white, as the plant tissue burns off a bright redness; if such a clay. however be heated to quickly, the surface of it becomes dense before all o the organic matter has had opportunity to escape fro the interior, and the latter remains dark colored.

Organic matter may also mask the presence of iro so that the clay, instead of burning white, will bur red at a temperature of above that at which the organic matter passes off, below that temperature th vegetable matter will tend to keep the iron reduced The clay from Fernbank, Lamar County, Alabama contains 6.40 per cent of ferric oxide, and 2 to 2 per cent of organic matter, but in the raw material, th latter hides the former. Organic matter exercises a important influence on the plasticity, often increasin it to an enormous degree, it also tends to elevate th tensile strength, the clay just mentioned showing 18 pounds per square inch, but high plasticity does no always indicate the presence of much organic material.

In the weathering of clays organic matter by it slow oxidation, aids in breaking them up by the escape of the carbonic acid gas.

WATER IN CLAYS.

All clays contain two kinds of water:—

1st. Hygroscopic water or moisture (mechanicall absorbed).

2nd. Chemically combined water.

The *moisture* in air dried clays may be as low as .5 per cent. and reach 30 to 40 per cent. in those freshly taken from the bank. In the air dried specimens in the Alabama samples tested, it varied from .12 per cent. to 3.4 per cent.

In air drying most of the moisture is expelled, and this is accompanied by a shrinkage of the clay, which, in the case of the Alabama samples, was usually from 2 to 7 per cent., but in one case it reached 14 per cent.

The air-shrinkage of the clay ceases however before all the moisture passes off, the reason for this being that the shrinkage ceases when the clay particles have come in contact with each other, but there may still remain spaces between them which hold the water by capillarity, and the brick will contiue to lose weight but not in size, until all of this water has been driven off.

In practice it is this latter portion of the moisture that evaporates during the first period of the burning known as water smoking.

The air shrinkage of a clay varies with the nature of the material. Sandy clays usually show the least shrinkage, and of this kind the coarse grained ones diminish the least in size, while highly plastic clays usually show a high contraction in volume.

The amount of water, which a dry clay needs to develop its maxium plasticity is a variable quantity. Plastic clays absorb a large amount, but a lean clay and fine grained one may do the same. As a very general rule it may be stated that lean clays absorb from twelve to twenty per cent. of water, while fat clays anywhere from twenty to fifty per cent., and the more water a clay absorbs the more it has to part with in drying and the greater will be its shrinkage.

If green ware is dried too rapidly it may split, not only from differential shrinkage between the exterior and the interior surface, but the rapid escape of steam may, in the first stage of the burning, tend to burst the ware.

Highly aluminous clays do not always absorb the most water, nor are they the most plastic, and some clays low in alumina and high in organic matter are not only highly plastic but also absorb a large quantity of water.

In the manufacture of clay products the moisture is partly expelled by exposing the ware to the sun or putting it in heated tunnels or rooms, while the last traces of moisture are driven off in the early stages of burning.

Moisture may play another important and injurious role in clay working by its tendency to dissolve the soluble salts in the clay and bring them to the surface in drying, where they are left in the form of a white coating. It may also permit the acids which are contained in the fire gases of the kiln, to act on the mineral ingredients of the clay, and thus form soluble compounds, especially clorides and sulphates.

Combined water is present in every clay. In pure kaolin there is nearly 14 per cent. of it, in other clays the percentage depends on the amount of clay base and the presence of other hydrated minerals, such as limonite.

Combined water is driven off at a low red heat, and when this occurs the clay suffers an additional shrinkage. It is a curious fact that although the combined water does not determine the degree of plasticity of the clay, nevertheless when once driven off the clay can no longer be rendered plastic. The greater the amount of combined water, the greater the shrinkage, and in the burning the Alabama clays it varied from 2½ to 12 per cent.

PHYSICAL PROPERTIES OF CLAYS.

These are fully as important as chemical ones, if not more so, plasticity for instance being a character of enormous value.

The physical characters which are of the most importance from the practical standpoint, are plasticity, fusibility, shrinkage, tensile strength, slaking, absorption and density.

PLASTICITY.

This is the property by virtue of which a clay can be moulded into any desired form when wet, which shape is retained by it when dry.

Just what the cause of plasticity is still remains to be definitely proven, although several theories, some of them very reasonable ones, have been advanced. It is an exceedingly variable property and we can find all stages in the transition from the highly plastic clay to the slightly coherent sand. Clays, which posses little plasticity are said to be lean, while highly plastic ones are called fat.

Pure or nearly pure kaolins are nearly always lean, while clays low in kaolinite may be highly plastic, thus for instance the clay from Chalk Bluff, and the stoneware from Prattville, containing respectively 36.50 and 26.98 per cent. of alumina are both lean, while the clays from Fayette Court House and Fernbank containing only 19.68 and 13 per cent. of alumina respectively are both highly plastic.

Cook has shown that the plasticity of some kaolins may be increased by grinding them, the result being to tear apart the little particles of clay which were bunched or clustered together and thus permit a greater mobility of the grains or scales of clay over each other.

Mica decreases the plasticity of clay, and if, in a finely divided condition, tends to make it flaky when wet.

Plasticity, whatever its cause, is an important property from a commercial standpoint and highly interesting from a scientific one. The amount of water required to develop the maximum plasticity varies. If too little is added the clay cracks in moulding and is stiff and hard to work; if too much is mixed in with the clay it becomes very soft and retains its shape with difficulty. Lean clays usually require less water to produce a workable mass than plastic ones.

The Alabama clays require from 25 to 30 per cent. of water to develop their maximum plasticity.

TENSILE STRENGTH.

The tensile strength or the binding power of a clay often stands in relation to its plasticity, but not always. It exerts an important effect in connection with the cracking of the ware in drying. The common method of determining it is to form the plastic clay into briquettes of the same shape as those used in the testing of cement. When air-dried they are tested in the regular cement testing machine, and their tensile strength per square inch is determined. Before breaking, the cross section of the briquette must be carefully measured, as the clay shrinks in drying and the tensile strength per square inch has to be calculated from this sectional area. ,

The tensile strength of air-dried clays is extremely variable. In kaolins it is from 5 to 10 pounds per square inch; in brick clays 60 to 75 pounds per square inch and even 100 pounds; in pottery clays from 150 to 175 pounds.

Some very plastic clays show as much as 200 and 300 pounds per square inch, and a tensile strength of even 400 pounds has been recorded.

The strongest Alabama clay were the highly plastic one from Chalk Bluff, which had a maximum tensile strength of 384 pounds per square inch, while the Choctaw County one showed only 5 pounds per square inch.

The Alabama clays were all ground and passed through a thirty mesh sieve before testing.

Very fine grained clays seem to be lacking in tensile strength as they are in plasticity.

SHRINKAGE.

All clays undergo a shrinkage in drying and an additional shrinkage in burning, the first is known as air —, the second as fire-shrinkage. Some clays shrink most in drying, others most in burning, and consequently the amount is variable and depends on the amount of water absorbed, on the amount of lime in the clay, the quantity of organic matter, the size of the grain, and the amount of combined water.

The amount of water absorbed, and the texture influence the air-shrinkage which begins as soon as the water commences to evaporate from the clay. It has already been mentioned that a clay keeps on losing in weight after the shrinkage has ceased, and this fact is well shown by the following experiments on some Alabama samples.

The clay was from property of J. C. Bean, Sec. 31, T. 20, R. 11 w.

After moulding, the clay weighed	35.698	grams.
At end of 24 hours the shrinkage was 11½ per cent. and the weight	30.891	"
At end of 48 hours, shrinkage 12 per cent., weight	29.588	"
At end of 6 days, shrinkage 12 per cent., weight	29.460	"
At end of 8 days, shrinkage 12 per cent., weight	29.140	"
At end of 12 days, shrinkage 12 per cent., weight	29.093	"

Throughout this period the clay was kept exposed to a temperture of 70° Fahr.

The shrinkage is generally equal in all three directions, and consequently only the linear shrinkage is given. The greater the shrinkage of a clay the more danger there is of its cracking and warping in burning, and when there is any apprehension that this may occur, an attempt is made to prevent it by the addition of grog (burned clay) which diminishes the shrinkage.

Coarse grain clays having larger pores permit the water to escape more rapidly, and hence can be dried more quickly than fine grained ones, from which the water can not very readily escape. If the drying of fine grained clays is hastened, the surface shrinkage is more rapid than that of the interior and cracking ensues. We might perhaps expect that on account of their greater porosity, the fine grained clays would absorb more water, and consequently shrink more in drying. but the Alabama clays do not always bear out this fact.

The fire shrinkage generally commences when the combined water begins to pass off, and it may be just as variable as the air shrinkage. In fine grained clays, as those from near Prattville, the shrinkage from burning was found to be comparatively uniform, while on the other hand moderately fine grained kaolin from Rock Run shrank more rapidly as it approached the temperature of vitrification.

Sometimes the clay instead of shrinking during the burning appears to expand; and this is especially the case with very quartzose ones, for the quartz has the property of expanding at high temperatures. This expansion of siliceous clays may sometimes be responsible for the presence of cracks in the burned ware.

As the addition of quartz to diminish the shrinkage also tends to decrease the tensile strength of the clay, there will be a certain limit beyond which it must not proceed.

Organic matter and combined water tend to increase the shrinkage in burning, but lime has the oposite tendency.

Clays containing a large amount of feldspar will, instead of showing a steady shrinkage up to the temperature of complete vitrification, often exhibit a temporary increase of volume when the fusing point of the feldspar is reached.

The shrinkage of most clays in burning does not proceed regularly and steadily up to the temperature of vitrification, for some clays attain their maximum density at a comparatively low temperature, below that at which they vitrify. Thus the plastic clay of J. C. Bean, near Tuscaloosa, attains its maximum shrinkage at cone 5, but does not vitrify until cone 27.

Between the point at which the moisture seems to pass off and that at which the combined water begins to escape, the clay shrinks little or none at all, and consequently the heat can be raised rapidly in this interval, but above and below these two points it must proceed slowly to prevent cracking or warping of the ware.

FUSIBILITY OF CLAYS.

It can be said in general, that other things being equal, the fusibility of a clay will increase with the all the fuxing impurities do not act with the same in- approximate statement however, for in the first place all the fluxing impurities do not act with the same intensity, and of two clays containing the same amount and kind of fluxes, that one which has the finer grain will usually fuse at the lower temperature, in addition to this the condition of the fire, whether oxidizing or reducing, also exerts an effect.

White mica tends to increase the refractoriness of a clay, and to exert very little fluxing action even at moderatly high temperatures.

As a clay is gradually heated, it not only shrinks, but also begins to harden. At the temperature at which the combined water begins to pass off, the impure clays acquire such a degree of hardness that they can no longer be scratched by a knife; but in the case of purer clays, the temperature must be raised much higher to obtain this same degree of hardness. This condition is brought about by the clay particles beginning to soften under the action of the heat, in other words it represents the very first stages of melting or incipient fusion, and in this condition the clay particles stick to each other, and bind the whole together into a solid mass. In clays which have been burned to incipient fusion, the particles are however still recognizable. If the temperature be increased, a variable amount, depending upon the clay, the result is that all of the particles become sufficently soft to permit their adjustment into a condition of greater compactness, leaving no interspaces, or in other words, the clay becomes impervious. This condition is spoken of as virtification, or complete sintering. The particles of the clay are no longer recognizable, and the maximum shrinkage has been reached. With a further elevation of the temperature the clay mass fusses completely, and becomes viscous or flows.

We therefore can recognize three stages in the burning of the clay, i. e., incipient fusion, vitrification and viscosity.*

The points of incipient fusion and viscosity may be within 75 degrees Fahr. of each other as in calcareous clays, while in some fire clays they may be as much as 500 or 600 degrees apart, and furthermore the point of vitrification does not necessarily lie midway between the two.

Most clays show a difference of from 200 to 400 degrees Fahr. between the points just mentioned, and it can be easily understood the farther apart these two points, the safer will it be to burn the clay, for it is not always possible to control a kiln within a range of a few degrees of temperature, and therefore in burning a mass of ware to vitrification if this point lies too near that of viscosity, there is danger of overstepping it and reaching the latter.

The fusibility of a clay depends on:

1. The amount of fluxes.
2. Size of the grain of the refractory and the nonrefractory constituents.
3. The condition of the fire, whether oxidizing or reducing.

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*These three terms have been suggested by H. A. Wheeler, Vitrified Paving Brick, 1895.

Attempts have been made to express the relative fusibiliy of clays numercally, and this number has been called the *refractory quotient* by Bishop[*] and the fusibility factor by Wheeler.[§] In both cases, the figure is obtained by using the non-fluxing elements of the clay for the numerator, and the fluxing impurities as a denominater; and in the case of the second formula, the fineness of the grain was also taken into consideration. As this mode of expressing the fusibility has not come into general use, the reference is simply given here.

On the other hand, it is customary to express the fusibility of the clay in degrees of temperature, and this temperature is measured by one or another form of pyrometer, whose principle depends on the fusion of alloys or single metals; thermo-electricity; fusion of an artificial mixture; spectro photometry; expansion of gases or solids; etc. Many of these are only applicable at lower temperatures, others are largely influenced by the personal equation, and only two or three of the most important will therefore be mentioned here.

THE THERMO-ELECTRIC PYROMETER.

Le Chatelier's Thermoelectric pyrometer depends on the measurement of a current generated by the heating of a thermo-pile. The latter consists of two wires, one of platium, the other an alloy, 90 per cent. platinum and 10 per cent of rhodium, twisted together at their free ends for a distance of about an inch, while the next foot or two of their lenth is enclosed in a fire clay tube so that when the couple is inserted into the furance only the end which is held near the body whose temperature is to be measured, will receive the full force of the heat. The two wires connect with a galvanometer, the deflection of whose needle increases with the temperature at the point of the free end of the wire couple. As at present put on the market, the thermo-electric pyrometer, costs about $180 and this, together with the delicacy of the galvanometer, has tended to restrict its use. There is no reason however why one should not be made and put on the market for a much lower price. It is not necessary that the recording instrument should be in immediate vicinity of the kiln, but it may be kept in another room where it is safe from dust and rough handling, and wires can extend from there to the kiln. This pyrometer is considered to be accurate to within 10 degrees Fahr.

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[*] Die Feuerfesten Thone, p. 71, 1876.

[§] English and Mining Journal, March 10, 1894.

SEGER PYRAMIDS.

These consists of different mixtures of kaolin and fluxes, which are compounded so that there shall be a constant difference between their fusing points. Segar's series were numbered from one to twenty, and the difference between any twoiconsecutive numbers is 36 degrees Fahr. A later series introduced by Cramer runs from .01 to .022 with a difference of 54 degrees Fahr. between their fusing points, and in addition the higher numbers in the Segar series have been extended from number twenty up to number thirty-six. As these cones have been recently recalibrated, the fusing points of the various numbers together with their composition is given herewith.*

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* Taken from a recently issued circular of Thon industrie Saboratorium in Berlin, where the cones are and were originally made.

No. of Cone.	Composition.			Fusion Point Cent.	Fusion Point Fahr.
022	0.5 Na_2O 0.5 PbO	—	2 SiO_2 1 B_2O_3	590	1094
021	0.5 Na_2O 0.5 PbO	0.1 Al_2O_3	2.2 SiO_2 1 B_2O_3	620	1148
020	0.5 Na_2O 0.5 PbO	0.2 Al_2O_3	2.4 SiO_2 1 B_2O_3	650	1202
019	0.5 Na_2O 0.5 PbO	0.3 Al_2O_3	2.6 SiO_2 1 B_2O_3	680	1256
018	0.5 Na_2O 0.5 PbO	0.4 Al_2O_3	2.8 SiO_2 1 B_2O_3	710	1310
017	0.5 Na_2O 0.5 PbO	0.5 Al_2O_3	3 SiO_2 1 B_2O_3	740	1364
016	0.5 Na_2O 0.5 PbO	0.55 Al_2O_3	3.1 SiO_2 1 B_2O_3	770	1418
015	0.5 Na_2O 0.5 PbO	0.6 Al_2O_3	3.2 SiO_2 1 B_2O_3	800	1472
014	0.5 Na_2O 0.5 PbO	0.65 Al_2O_3	3.3 SiO_2 1 B_2O_3	830	1526
013	0.5 Na_2O 0.5 PbO	0.7 Al_2O_3	3.4 SiO_2 1 B_2O_3	860	1580
012	0.5 Na_2O 0.5 PbO	0.75 Al_2O_3	3.5 SiO_2 1 B_2O_3	890	1634
011	0.5 Na_2O 0.5 PbO	0.8 Al_2O_3	3.6 SiO_2 1 B_2O_3	920	1680
010	0.3 K_2O 0.7 CaO	0.2 Fe_2O_3 0.3 Al_2O_3	3.50 SiO_2 0.50 B_2O_3	950	1742
09	0.3 K_2O 0.7 CaO	0.2 Fe_2O_3 0.3 Al_2O_3	3.55 SiO_2 0.45 B_2O_3	970	1778

No. of Cone.	Composition.			Fusion Point Cent.	Fusion Point Fahr.
08	$0.3\ K_2O$ $0.7\ CaO$	$0.2\ Fe_2O_3$ $0.3\ Al_2O_3$	$3.60\ SiO_2$ $0.40\ B_2O_3$	990	1814
07	$0.3\ K_2O$ $0.7\ CaO$	$0.2\ Fe_2O_3$ $0.3\ Al_2O_3$	$3.65\ SiO_2$ $0.35\ B_2O_3$	1010	1850
06	$0.3\ K_2O$ $0.7\ CaO$	$0.2\ Fe_2O_3$ $0.3\ Al_2O_3$	$3.70\ SiO_2$ $0.30\ B_2O_3$	1030	1886
05	$0.3\ K_2O$ $0.7\ CaO$	$0.2\ Fe_2O_3$ $0.3\ Al_2O_3$	$3.75\ SiO_2$ $0.25\ B_2O_3$	1050	1922
04	$0.3\ K_2O$ $0.7\ CaO$	$0.2\ Fe_2O_3$ $0.3\ Al_2O_3$	$3.80\ SiO_2$ $0.20\ B_2O_3$	1070	1958
03	$0.3\ K_2O$ $0.7\ CaO$	$0.2\ Fe_2O_3$ $0.3\ Al_2O_3$	$3.85\ SiO_2$ $0.15\ B_2O_3$	1090	1994
02	$0.3\ K_2O$ $0.7\ CaO$	$0.2\ Fe_2O_3$ $0.3\ Al_2O_3$	$3.90\ SiO_2$ $0.10\ B_2O_3$	1110	2030
01	$0.3\ K_2O$ $0.7\ CaO$	$0.2\ Fe_2O_3$ $0.3\ Al_2O_3$	$3.95\ SiO_2$ $0.05\ B_2O_3$	1130	2066
1	$0.3\ K_2O$ $0.7\ CaO$	$0.2\ Fe_2O_3$ $0.3\ Al_2O_3$	$4\ SiO_2$	1150	2102
2	$0.3\ K_2O$ $0.7\ CaO$	$0.1\ Fe_2O_3$ $0.4\ Al_2O_3$	$4\ SiO_2$	1170	2138
3	$0.3\ K_2O$ $0.7\ CaO$	$0.05\ Fe_2O_3$ $0.45\ Al_2O_3$	$4\ SiO_2$	1190	2174
4	$0.3\ K_2O$ $0.7\ CaO$	$0.5\ Al_2O_3$	$4\ SiO_2$	1210	2210
5	$0.3\ K_2O$ $0.7\ CaO$	$0.5\ Al_2O_3$	$5\ SiO_2$	1230	2246
6	$0.3\ K_2O$ $0.7\ CaO$	$0.6\ Al_2O_3$	$6\ SiO_2$	1250	2282

No. of Cone.	Composition.			Fusion Point Cent.	Fusion Point Fahr.
7	$0.3\ K_2O$ $0.7\ CaO$	$0.7\ Al_2O_3$	$7\ SiO_2$	1270	2318
8	$0.3\ K_2O_3$ $0.7\ CaO$	$0.8\ Al_2O_3$	$8\ SiO_2$	1290	2354
9	$0.3\ K_2O$ $0.7\ CaO$	$0.9\ Al_2O_3$	$9\ SiO_2$	1310	2390
10	$0.3\ K_2O$ $0.7\ CaO$	$1.0\ Al_2O_3$	$10\ SiO_2$	1330	2426
11	$0.3\ K_2O$ $0.7\ CaO$	$1.2\ Al_2O_3$	$12\ SiO_2$	1350	2462
12	$0.3\ K_2O$ $0.7\ CaO$	$1.4\ Al_2O_3$	$14\ SiO_2$	1370	2498
13	$0.3\ K_2O$ $0.7\ CaO$	$1.6\ Al_2O_3$	$16\ SiO_2$	1890	2534
14	$0.3\ K_2O$ $0.7\ CaO$	$1.8\ Al_2O_3$	$18\ SiO_2$	1410	2570
15	$0.3\ K_2O$ $0.7\ CaO$	$2.1\ Al_2O_3$	$21\ SiO_2$,	1430	2606
16	$0.3\ K_2O$ $0.7\ CaO$	$2.4\ Al_2O_3$	$24\ SiO_2$	1450	2642
17	$0.3\ K_2O$ $0.7\ CaO$	$2.7\ Al_2O_3$	$27\ SiO_2$	1470	2678
18	$0.3\ K_2O$ $0.7\ CaO$	$3.1\ Al_2O_3$	$31\ SiO_2$	1490	2714
19	$0.3\ K_2O$ $0.7\ CaO$	$3.5\ Al_2O_3$	$35\ SiO_2$	1510	2750
20	$0.3\ K_2O$ $0.7\ CaO$	$3.9\ Al_2O_3$	$30\ SiO_2$	1530	2786

conditions during burning, with the results obtained, may lead to a discovery of those conditions that will produce the best product.

CHEMICAL EFFECTS OF HEATING.

While the fusion of a clay may be looked upon in part as a chemical action, there are other changes which take place in the clay before the temperature of fusion is reached. These changes are:

The driving off of the chemically combined water.

The burning of the organic matter.

The change of limonite to hematite by the loss of its combined water.

The oxidization of pyrite to sulphate which by further heating loses its sulphur and is also converted into hematite.

The driving off of carbonic acid from any carbonates of lime or magnesia which may be present.

The general effect of these changes is first to make the clay more porous, but subsequently to increase its shrinkage, and in addition the color of the clay is changed.

A chemical interaction between the components of the clay only begins with incipient fusion.

SLAKING.

Clays, when thrown into water, break up more or less completely, or in other words, they slake. The process is simply one of mechanical disintegration, which, however, has important practical bearings. Some homogeneous clays on being immersed split into a number of angular fragments, while others flake off into scaly particles, while still others crumble down to a powder. This slaking action proceeds slowly or quickly depending on the toughness or density of the clay. Some clays slake completely in two or three minutes, while others may be little effected by an immersion in water of an hour or two.

The practical importance of slaking is noticed first in the case of clays which have to be washed for marketing, for the quicker they fall apart when they are thrown into water, the more rapid and sometimes the more thoroughly will be the elimination of the impurities.

In the tempering the easy slaking of a clay is also of importance, permitting it to be more easily broken up and the more thoroughly mixed with water.

ABSORPTION.

This varies with the amount of organic matter, ferric hydrate, and the porosity of a clay, and increases with all three. As has already been stated the more water a clay absorbs the more it has to give off in drying and the more difficult it is, especially in the case of fine grained clays, to avoid cracking.

COLOR OF UNBURNED CLAYS.

Ferric oxide and organic matter are the two great coloring agents of the raw clay. Organic matter generally colors a clay gray, bluish gray, or black, while iron according to the condition of the oxide, or the presence of carbonate, may impart a red, yellow brown, or sometimes a gray color.

For any given amount of organic matter or ferric oxide, the coloration will be much more intense the more sandy the clay.

In general it may be said that, organic matter excepted, the purer clays are usually light colored, while the impure ones are yellow, red, or brown.

Organic matter however, frequently masks the iron coloration, and makes it often difficult to determine the refractory nature of the material. Some clays which burn perfectly white may be colored black by organic matter as in the case of the sand clay from Pegram. Ferrous compounds not infrequently impart a gray or bluish tint to clay, and at times the lower part of a clay bed may be gray while the upper portion is yellow or red, due to the oxidation of the iron contained in it.

THE MINERALOGY OF CLAYS.

Most clays are so fine grained that it is impossible to determine the mineral constituents with the naked eye, and their recognition even microscopically, is sometimes a matter of diffculty. At the same time however, there are certain minerals, which are either present in all clays or are to be found in a great many of them, and these will be mentioned in the order of their abundance.

KAOLINITE.

The mineral kaolinite is looked upon as the base of all clays, and while it is not wanting so far as we know in any of them, nevertheless, it is not as abundant as we have been apt to consider it, nor are the characteristic properties of clay wholly due to it.

Kaolinite, whose formula is Al_2O_3, $2SiO_2$, $2H_2O$, or silica 46.3 per cent., alumina 39.8 per cent., water 13.9 per cent is a white scaly mineral crystallizing in the monoclinic system, the crystals presenting the form of small hexagonal plates. Its specific gravity is 2.2

to 2.6 and its hardness is 2 to 2½. It is naturally white in color and plastic when wet but very slightly so. The microscope shows the kaolinite to be collected in little bunches which can be broken apart by grinding and thereby increasing the plasticity.*

Kaolinite is nearly infusible but a slight addition of fusible impurities lowers its refractoriness. A mass of kaolinite is called kaolin, and pure kaolin is practically unknown.

Many kaolins contain very minute scales of white mica, which under the microscope are hardly distinguishable from kaolinite. It is not to be inferred that kaolinite always occurs in hexagonal plates, for in some clays scales of six sided outline are almost wanting.

QUARTZ.

This mineral is present in sedimentary clays mostly in the form of rounded grains, and sometimes in crystals, while in residual clays the particles are most commonly angular. It is an extremely hard mineral, which will scratch glass and possesses a shell like or conchoidal fracture, it is practically not attacked by the common acids, but is affected by alkaline solutions. This is one of the few mineral components of clay which, at times, occurs in grains of sufficient size to be recognized by the unaided eye. It may be colorless but the surface of the grain is not infrequently stained by a thin film of iron oxide. Feldspar might be mistaken for it, but the latter will not scratch glass.

Flint or non-crystalline silica is sometimes present in clays. It usually has a muddy color and a conchoidal fracture.

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*G. H. Cook, Clays of New Jersey, Geological Survey, 1878.

Both quartz and flint are infusible at very high temperatures but the presence of other minerals may serve to flux them. Quartz tends to diminish the shrinkage of the clay, and if wanting it has to be added during the process of manufacture. Its addition also tends to decrease the plasticity.

CALCITE.

This mineral which is carbonate of lime, effervesces when moistened with muriatic acid, so that its presence in clay may often be detected by the addition of this chemical. Calcite is a soft mineral and occurs in the clay, either in the form of little rhombohedral or powdery particles. Clays, which contain a large amount of it in finely divided condition, are said to be marly, and in some clay deposits certain layers may contain a larger percentage of carbonate of lime than others. The carbonate of lime found in clays may be derived from particles of limestone in the clay if it is a sedimentary one, or from the decomposition of lime-soda feldspar in the case of either sedimentary or residual deposits. Percolating water may also introduce it into the clay.

GYPSUM.

Gypsum or the sulphate of lime is found in clay in the form of grains, needles, well developed crystals, or lamellar masses. It is so much softer than calcite that it can be scratched by the finger nail, often has a pearly lustre, is transparent, and does not effervesce when acid is poured on it. In hard burned brick gypsum simply acts as a flux, but in lightly burned ones it gives rise to soluble sulphates which cause efflorescence.

MICA.

This mineral can be frequently detected by the naked eye, owing to its high lustre, even when it is present in the form of very minute scales. It is seldom absent in clays and is usually found to an appreciable extent in even the best kaolins, for on account of its scaly nature and lightness, it remains suspended in water for a long while and is consequently very hard to remove by washing; small amounts of white mica are rarely injurious.

Mica is usually found in those clays which have been derived from the breaking down of igneous or metamorphic rocks, such as granites, gneisses or schists, and two species are recognized in clay, i. e. biotite and muscovite. The former is a complex silicate of iron, magnesia, and alumina, and occurs as six sided plates or irregular scales usually of a dark color. As it easily decomposes with the formation of iron oxide, it is not so apt to be found in clays as the muscovite, which is more resistant to weathering. The muscovite is sometimes called potash mica, although it also contains a small amount of iron and magnesia; it is of silvery white or light brown color.

Mica decreases the plasticty of clay, and tends to make it flaky when wet, if in a finely divided condition.

White mica tends to increase the refractoriness of a clay, and to exert very little fluxing action, even at moderately high temperatures.

IRON OXIDE.

This, next to quartz, is perhaps the commonest mineral impurity of clay. It occurs as earthy grains, as metallic scales or as a superficial coating on other mineral grains found in the clay. It dissolves quietly in muriatic acid. Iron may also occur in the clay as a constituent element of many silicates, and indeed the effect which it produces may be caused not so much by the actual amount of iron oxide which is present, but by the condition which it is in.

Iron oxide is very apt to form concretions in the clay, and these concretions which generally have a shell-like structure, vary in diameter commonly from a fraction of an inch to several inches. Siderite, the carbonate of iron, which is also to be found in many clays, likewise forms concretions or opaque rounded masses, which effervesce on the addition of warm muriatic acid. The exterior of these siderite concretions is not unfrequently altered to limonite, the brown or yellowish hydrated oxide of iron. Such concretions are hard and rock-like in their nature, and either have to be separated by screening the clay before using, or crushed by passing the clay between rolls.

PYRITE.

This mineral is a compound of iron and sulphur, and the grains of it are easily recognized by their metallic lustre and their yellow color. It is a very common constituent of many fire clays, and occurs either in the form of small grains or concretionary masses of yellow crystals. Its bright metallic surface will serve to distinguish it from limonite which has a dirty appearance.

DOLOMITE.

This is a double carbonate of lime and magnesia, and may occur in a clay in the same form as calcite, and the effect of it is practically the same.

METHODS EMPLOYED IN MAKING CLAY ANALYSES.*

The following brief statement of the methods employed in making the analyses of clays for this report has been prepared by Dr. Charles Baskervill, by whom the analyses were made:

Moisture—Two grams are heated in a platinum crucible at 100° C. until they show a constant weight. The loss is reported as moisture.

Loss on Ignition (combined water, and sometimes organic matter, etc.)—The crucible and clay are heated with a blast lamp until there is no further loss in weight.

Alkalies—This same portion of clay, which has been used for determining moisture and loss, is treated with concentrated sulphuric and hydrofluoric acids until it is completely decomposed. The acids are evaporated off by heating upon the sand-bath. The cooled crucible is washed out with boiling water to which several drops of hydrochloric acid have been added. The solution after being made up to about five hundred cubic centimetres is boiled, one-half gram ammonia oxalate added and made alkaline with ammonium hydroxide; the boiling is continued until but a faint odor of ammonia remains. The precipitate is allowed to settle and is separated from the liquid by filtering and washed three times with boiling water. The filtrate is evaporated to dryness and ignited to drive off ammonia salts. The residue is treated with five cubic centimetres of boiling water, two or three cubic centimetres of saturated ammonium carbonate solution are added and the whole is filtered into a weighed crucible or dish. The precipitate is washed three or four times with boiling water and the filtrate evaporated to dryness. Five drops of sulphuric acid are added to the residue, and then the crucible or dish is brought to a hot heat, cooled in a desicator, and the alkalies are weighed as a sulphate.

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*Reprinted from Bulletin No. 13, North Carolina Geological Survey, 1897.

To separate the alkalies, the sulphates are dissolved in hot water, acidified with hydrochloric acid, sufficient platinum chloride added to convert both sodium and potassum salts into double chlorides; the liquid is evaporated to a syrup upon a water-bath, eight per cent. alchohol added, and filtered through a Gooch crucible or upon a tared filter paper. The precipitate is thoroughly washed with eighty per cent. alcohol, dried at 100° C. and weighed; the potassium oxide is calculated from the double chloride of potassium and platinum.

When magnesium was present to as much as one-half of one per cent., the magnesium hydroxide was precipitated with barium hydroxide solution and the barium in turn removed by ammonium carbonate. When the amount of magnesium was less than the amount named, this portion of the ordinary process was not regarded as necessary.

Silica—Two grams of clay are mixed with ten grams of sodium carbonate and one-half gram of potassium nitrate and brought to a calm fusion in a platinum crucible over the blast lamp. The melt removed from the crucible is treated with an excess of hydrochloric acid and evaporated in a casserole to dryness upon a water-bath, and heated in an air-bath at 110° C. until all the hydrochloric acid is driven off. Dilute hydrochloric acid is added to the casserole now, and the solution brought to boiling and rapidly filtered.

The silica is washed thoroughly with boiling water and then ignited in a platinum crucible, weighed, and moistened with concentrated sulphuric acid. Hydroflouoric acid is cautiously added until all the silica has disappeared. The solution is evaporated to dryness upon a sand-bath, ignited and weighed. The difference in weight is silica.

Iron Sesquioxide—The filtrate from the silica is divided into equal portions. To one portion in a reducing flask is added metallic zinc and sulphuric acid. After reduction and filtration to free the liquid from undissolved zinc·and carbon, the iron is determined by titration with a standard solution of potassium permanganate.

Aluminium Oxide—To the second portion, which must be brought to boiling, ammonium hydroxide is added in slight excess, the boiling continued from two to five minuts, the precipitate allowed to settle and then caught upon the filter, all of the chlorides being washed out with boiling water. The precipitate is ignited and weighted as a mixture of aluminium oxide and iron sesquioxide. The amount of iron sesquioxide already found is taken from this and the remainder reported as alumina.

Calcium Oxide—The filtrate from the precipitate of iron and aluminium hydroxides is concentrated to about two hundred cubic centimetres, and the calcium precipitated in a hot solution by adding one gram of ammonium oxalate. The precipitate is allowed to settle during twelve hours, filtered and washed with hot water, ignited and weighed as calcium oxide. When the calcium is present in notable amounts, the oxide is converted into the sulphate and weighed as such.

Magnesium Oxide—The filtrate from the calcium oxalate precipitate is concentrated to about one hundred cubic centimetres, cooled, and the magnesium precipitated by means of hydrogen disodium phosphate in a strongly alkaline solution, made so by adding ten cubic centimetres of ammonium hydroxide (0.90 sp. gr.). The magnesium ammonium phosphate, after standing over night, is caught upon an ashless filter, washed with water containing at least five per cent. ammonium hydroxide, burned and weighed as magnesium pyrophosphate.

The *insoluble residue* is determined by digesting two grams of clay with twenty cubic centiments of dilute sulphuric acid for six or eight hours on a sand-bath, the excess of acid being finally driven off. One cubic centimetre of concentrated hydrochloride acid is now added and boiling water. The insoluble portion is filtered off, and after being thoroughly washed with boiling water is digested in fifteen cubic centimetres of boiling sodium hydroxide of ten per cent. strenth. Twenty-five cubic centimetres of hot water are added and the solution filtered through the same filter paper, the residue being washed five or six times with boiling water. The residue is now treated with hydrochloric acid in the same manner and washed upon the filter paper, and free from hydrochloric acid, is burned and weighed as insoluble residue.

A portion of this is treated as the original clay for silica, aluminium oxide and iron oxide. Another portion is used for the determination of the alkalies in the insoluble residue.

Titanic Oxide—One-half gram of clay is fused with five grams potassium bisulphate and one gram sodium fluoride in a spacious platinum crucible. The melt is dissolved in five per cent. sulphuric acid. Hydrogen dioxide is added to an aliquot part and the tint compared with that obtained from a standard of titanium sulphate.

Sulphur (total present)—The sulphur is determined by fusing one-half gram of clay with a mixture of sodium carbonate, five parts, and potassium nitrate, one part. The melt is brought into solution with hydrochloric acid. The silica is separated by evaporation, heating, resolution, and subsequent filtration. Hydrochloric acid is added to the filtrate to at least five per cent. and the sulphuric acid is precipitated by adding barium chloride in sufficient excess, all solutions being boiling hot. The barium sulphate is filtered off and washed with hot water, burned and weighed as such.

Ferrous Oxide—is determined by fusing one-half gram of clay with five grams sodium carbonate, the clay being well covered with the carbonate, the top being upon the crucible. The melt is dissolved in a mixture of dilute hydrochloric and sulphuric acids in an atmosphere of carbon dioxide. The ferrous iron is determined at once by titration with a standard potassium permanganate solution.

The *rational analysis* is made from the results obtained by the chemical analysis in the following way: The alumina found in the portion insoluble in sulphuric acid and sodium hydroxide is multiplied by 3.51. This factor has been found to represent the average ratio between alumina and silica in orthoclase feldspar; therefore the product just obtained would represent the amount of silica that would be present in undecomposed feldspar. The sum of this silica with the alumina, ferric oxide and alkalies equals the "feldspathic detritus." The difference between silica as calculated for feldspar and the total silica in the insoluble portion represents the "quartz" or "free sand." The difference between that portion of the sample insoluble in sulphuric acid and sodium hydroxide and the total represents the "clay substance." The method of analysis used to detrmine the mineralogical character of the clay is called the *rational* method, and when carried out in its simplest form, determines the amount of clay substance or kaolinite, quartz, and feldspar present 'n the clay. If carried out more completely, it enables us to calculate the amount of calcite or limestone (calcium carbonate)' iron oxide and even mica in the clay.

THE RATIONAL ANALYSIS OF CLAY.

The rational analysis of clay consists in resolving the clay into its mineralogical elements, thus giving a clue to its physical as well as its chemical properties. It is often utilized by manufacturers of porcelain and other high grades of ware as a guide in the compounding of their mixtures.

The ordinary quantitative or ultimate analysis regards the clay as a mixture of oxide of the elements. although they may be present in entirely different combinations, such as silicates, carbonates, hydrates, sulphates, etc. This condition of combination is important for it makes a difference in the behavior of the clay. Thus for instance, if silica is present in the form of quartz it will decrease the shrinkage and also increase the refractoriness up to a certain point, but if present as a component element of feldspar it serves as a flux and also increases the plasticity somewhat.

It is not intended though that the rational analysis shall fully supplant the ultimate one for each serves its own purpose.

The ultimate analysis may be used to supply information on the following points.

1. The purity of the clay, by showing the proportions of silica, alumina, combined water and fluxing impurities.

2. From the ultimate analysis we can form a general idea regarding the refractoriness of the clay, for, other things being equal the greater the total sum of the fluxing impurities, the more fusible the clay.

3. The color to which the clay burns may also be judged approximately for the greater the amount of iron in the clay the deeper red will it burn, provided the iron oxide is evenly distributed, and there is not an excess of lime in the clay. If the proportion of iron to lime is as 1; 3, then a buff product results, provided the clay is only heated to incipient fusion or vitrification. The above conditions will be affected by a reducing atmosphere in burning or of sulphur in the fire gases.

4. Clays with a large amount of combined water sometimes exhibit a tendency to crack in burning. This combined water would be shown in the ultimate analysis.

5. A large excess of silica would indicate a sandy clay.

The connection between refractoriness and chemical composition may be illustrated by the following analysis.

The following analyses indicate this fact:

	1	2	3
	Per cent.	Per cent.	Per cent
SiO_2	47.20	69.50	54.90
Al_2O_3	36.50	13.00	18.03
Fe_2O_3	2.56	6.40	6.03
CaO	tr.	.25	2.88
MgO	tr.	tr.	1.10
Alkalies		tr.	3.40
H_2O	13.35	6.70	6.90
Moisture	.50	3.40	3.17
Total fluxes	2.56	6.65	13.41
	DEG. F.	DEG. F.	DEG. F.
Viscosity or fusion point.	Above 2700	2300	1900

1. Chalk Bluff, Marion Co., Ala., *U. S. Geol. Surv.* 18th *Ann. Rep.*, Part V. (continued), p. 1128.
2. Fernbank, Lamar Co., Ala. *Ibid.*
3. Norborne, Mo. *Mo. Geol. Surv.*, XI. *Ann. Rep.*

This is practically the full extent to which the ultimate analysis can be used; and there still remain to be explained a number of physical facts concerning any clay which happens to be under consideration.

It frequently happens that two clays approach each other quite closely in their ultimate composition, and still exhibit an entirely different behavior when burned. The explanation which most quickly suggests itself is, that the elements present in the two clays are differently combined. Some method of resolving the clay into its mineral components, so as to indicate the condition in which the elements are present is therefore practically needed.

As kaolinite results from the decomposition of feldspar, the kaolin is quite sure to contain some undecomposed feldspar, and also some quartz, and (in smaller amounts) mica, since the two latter minerals are common associates of the feldspar.

If, now, we know the amount of feldspar, quartz and kaolinite or clay-substance in the kaolin, and the effect of these individual minerals, we can form a far better opinion of the probable behavior of the clay in burning.

When mica is present, it is dissolved out with the kaolinite and reckoned in as clay-substance, but it is rarely present in large amounts, and may perhaps alter the character of the clay-substance but little, for finely ground white mica possesses plasticity, and can be formed and dried without cracking. It is more refractory than feldspar, and holds its form up to 1400° C.*

In the following table are given the ultimate and rational analyses of a number of kaolins, which show how a constancy of ultimate composition may be accompanied by variations in the rational analysis:

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* G. Vogl, *Chem. News*, 1890, p. 315.

TABLE I.—*Ultimate and Rational Analyses of Clays.*

	1	2	3	4	5	6	7	8	9	10	11	12
	ULTIMATE ANALYSIS.											
SiO_2	62.40	62.52	63.17	64.87	63.07	54.51	53.10	47.60	46.61	58.39	46.82	57.08
Al_2O_3	26.51	25.57	25.09	23.83	24.67	31.41	33.06	34.00	36·47	27.52	38.49	29.94
Fe_2O_3	1.14	.92	.64	.83	.59	.68	1.18	1.30	2.81	.36	1.09	.65
CaO	.57	.65	.35	....	....	.04	.38	Tr.	·14	1.52	....	....
MgO	·01	.10	.26	.50	.40	.43	.08	.50	....	.41	Tr.	.49
Alkalies	.98	1.04	.80	1.39	4.25	.55	.83	3.00	1.44	4.29	1.40	2.26
Loss by ignition	8.80	9.27	9.70	8.36	7.00	12.37	11.32	13.60	12.80	7.19	12.86	9.87
	100.41	100.07	100.01	99.78	99.98	99.99	99.95	100.00	100.27	99.68	100.66	100.29
	RATIONAL ANALYSIS.											
Clay substance	66.33	72.05	67.82	63.77	54.92	83.04	83.39	88.34	96.08	55.88	96.55	74.09
Quartz	15.61	27.78	30.93	35.50	23.52	16.28	14.99	8.95	1.93	5.95	2.30	17.21
Felspar	18.91	.10	1.25	.73	21.56	.28	1.57	2.73	1.99	38.17	1.15	8.70
	100.85	99.93	100.00	100.00	100.00	100.0	99.95	100.02	100.00	100.00	100.00	100.00

1. Crude kaolin, Springer mine, Webster, N. C. *Bull, N. C. Geol. Surv.*, on "Clays of North Carolina."
2. Slip-clay from Ruhle's mine, Lothian, Saxony. *Thon.-Ind.-Zeit.*, 1892, p. 1081.
3. Slip-clay from Kaschkau, Germany. *Ibid.*
4. Kaolin from Sennewitz, Saxony. *Notizblatt*, 1876.
5. Porcelain-clay mixture. *Ibid.*
6. White earthenware clay, Lothain, Saxony. *Seger's Ges. Schr.*, p. 887.
7. Kaolin (unwashed), West Mills, N. C. *Bull, N. C. Geol. Surv.*, on "Clays of North Carolina."
8. White earthenware clay, Wiesau, Germany. *Thon.-Ind.-Zeit.*, 1894, p. 858.
9. Fire-clay, Bautzen, Germany. *Ibid.*, 1894, p. 842.
10. Kaolin, Limoges, France. *Seger's Ges. Schr.*, p. 552.
11. Kaolin, Zettlitz, Bohemia. *Ibid.*, p. 50.
12. Kaolin, Lettin, Saxony. *Ibid.*, p. 50.

From this table a number of interesting conclusions may be drawn. Columns 1 and 2 represent two clays which agree very closely in their ultimate composition; but in the rational analysis there is a difference of 6 per cent. in the clay-substance, 12 per cent. in quartz, and nearly 19 per cent. in the feldspar. Nos. 3 and 5 and 10 and 12 also illustrate this point.

In Nos. 6 and 7, one a German, and the other a North Carolina kaolin, the ultimate analyses are very closely alike, and the rational analyses also agree very well. This is frequently the case when the clay-substance is very high, between 96 and 100 per cent., as in Nos. 9 and 11.

A third case would be presented if the rational analyses agreed, but the ultimates did not. Such instances, however, seem to be much less common.

The practical value of the rational analysis bears chiefly upon those branches of the clay-working industry, such as manufacture of porcelain, white earthenware, fire-brick and glasspots, which use materials with comparatively few fusible impurities (iron, lime, magnesia).

There is much concerning clays which sitll remains unexplained, but it seems probable that, other things being equal, two clays having the same *rational* composition will behave alike.

We can illustrate this point by the follownig tests made on washed kaolins from the vicinity of Sennewitz, near Halle, Germany. From the figures given below, it will be noticed that in the case of Nos. 1 and 2 there is a close agreement in the shrinkage, which amounted to about 10 per cent. when the clay was heated up to the temperature of a hard-porceclain kiln. In Nos. 3 and 4 the shrinkage is very nearly the same, but greater than in Nos. 1 and 2, because the rational composition has changed, there being a marked increase in the amount of feldspar.

If there hed been much difference in the size of the clay-particles of Nos. 3 and 4 or Nos. 1 and 2, the shrinkage in each case would probably have been different.

TABLE II.—*Rational Analysis and Shrinkage of Clays.*

Feldspar. Per cent.	Quartz. Per cent.	Clay-Substance. Per cent.	Fe_2O_3 Per cent.	Shrinkage in Hard Porcelain Fire Per cent
1.59	33.86	64.55	0.75	10.20
1.21	33.39	65.40	0.73	10.10
8.64	31.69	59.68	0.30	12.90
8.25	35.15	56.60	0.30	12.00

The degree of fineness of the clay-particles, and perhaps their shape also, probably exert more influence on the shrinkage than has been imagined, but just how far this makes itself felt is still undetermined.

As an illustration of the practical use of the rational analysis we may take the following:

Suppose that we are using for the manufacture of porcelain or fire-brick a kaolin which has 67.82 per cent. of clay-substance, 30.93 of quartz, and 1.25 of feldspar, and that to 100 parts of this is added 50 parts of feldspar. This would give us a mixture of 45.21 per cent. of clay substance, 20.62 of quartz, and 34.17 of feldspar.

If now for the clay we had been using, we substituted one with 66.33 per cent. of clay-substance, 15.61 of quartz. and 18.91 of feldspar, and made no other changes, the mixture would then contain 44.22 per cent. of clay-substance, 10.41 of quartz and 45.98 of feldspar.

This last mixture shows such an increase in feldspar that it must give much greater shrinkage and fusibility; but knowing the rational analysis of the new clay, it would be easy to add quartz or feldspar so as to bring the mixture back to its normal composition.

The application of the method of rational analysis to impure clays is not quite as satisfactory, but at the same time not as necessary. In the treatment, the iron, if present as oxide, and lime or magnesia, if carbanotes, are dissolved out with the clay-substance. The silicate minerals are grouped with the feldspar, and the clay thus becomes divided into clay-substance (kaolinite, ferric oxide, lime and magnesia carbonates), feldspar or feldspathic detritus; and quartz. If the percentage of ferric oxide and carbonates is high, it is necessary to determine them separately in the ultimate analysis.

In making a rational analysis, the clay is treated with strong sulphuric acid, which decomposes the kaolin into sulphate of alumina and hydrous silica. The former is soluble in water, while the latter is removed with caustic soda, and we get an insoluble residue consisting of quartz and feldspar. In this residue the alumina is determined and the feldspar calculated.

Another way of conducting the rational analysis, and one which is chiefly applicable when the clay contains other minerals besides the kaolin, quartz and feldspar, such as carbonate of lime, ferric oxide, or mica, consists in analysing the insoluble residue and calculating the mineral percentages from this.

THE CLASSIFICATION OF CLAYS.

As it is possible to find every gradation from the purest to the most impure clays any classification that is attempted, will necessarily be more or less unsatisfactory. It is of course possible primarily to make two great divisons i. e. residual and sedimentary, and to these might perhaps be added a third class of clays, namely, those formed by chemical precipitation. Under each of the first two classes, it would be possible again to find every gradation from pure to impure.

It is not possible to make any classification based upon the practical applications of the materials, for some clays are used for as many as four to five different purposes, and it is probable that some classification which simply recognizes four or five important groups is probably the most satisfactory and the least confusing. Hill makes the following divisions:*

China clays.
Plastic, ball, pottery clays.
Brick clays.
Refractory or fire clays.

He furthermore makes another table based on the origin of the clay as found in the United States:

I—WHITE BURNING CLAYS.

1. Rock or residual kaolin.
2. Indianite or Indiana kaolin.
3. Florida or sedimentary kaolins.
4. White burning plastic clays.

II—COLOR BURNING CLAYS.

Mixed clays—

1. Brick clays, (Siliceous).
2. Marly clays, (Calcareous).
3. Pink clays, (Ferruginous).
2. Cement clays, (Silico-calcareous).
5. Alum clays.

Altered clays (shale and slate).

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*U. S. Geol. Survey, Mineral Resources, 1893.

A classification which has been made by Seger, the great German Ceramic Chemist, gives:

1. *Yellow burning,* containing lime and iron.
2. *Red burning,* non-aluminous, ferruginous clays, which are free from lime.
3. *White and yellow burning.* These clays are low both in lime and iron.
4. *White burning,* low in iron and high in alumina.

THE MINING AND PREPARATION OF CLAYS.

RPOSPECTING FOR CLAYS.

Clay deposits are best seen in those regions where rivers and brooks have cut gullies and ravines, the clay showing on the sides of the cut. In such locations the thickness of the deposit and variation in its character vertically are well shown. Similar sections are to be loooked for along railroads. As the beds are apt to wash down it is necessary to clean the surface of the cut before taking any sample for testing, and even then great care must be observed to insure the sample being an average one.

Apart from cuts the presence of clay can often be determined by the character of the vegetation, the nature of the soil, or upturned tree roots.

The outcropping of clay in a ravine should not be depended on alone, but in addition borings should be made to determined the depth and extetnt of the deposit, and persistance of the different layers if there is a variation in them.

Shale often forms cliffs or steep slopes, at the base of which there may be a talus of partly weathered fragments and soft clay; in fact the outcrop of a shale deposit may be covered by the clay into which it has slaked under the influence of weathering. In some localities this mellowed outcrop may be only a few feet thick, but in many it is of sufficient volume to supply a small brick yard, without the necessity of attacking the fresh shale beneath.

MINING OF CLAYS*.

Clays, when soft and plastic, are mostly dug with pick and shovel, loaded on wheel-barrows, carts or cars and hauled to the works. If the deposit is broad and shallow the clay is usually dug at any convenient point; often any overlying sand or other useless material has been first removed and used for filling in or some other purpose.

If the bank is located on the hillside, and has considerable height, it is worked out in broad steps, the object of this being to prevent the bank from sliding in wet weather.

When the bank is near the works, wheel-barrows or carts can be used to haul the clay, but far distances, over 600 feet, it pays to lay tracks and use cars, hauled either by horse or steam power.

Underground methods of mining are only used in case the amount of overlying material is very great. It is chiefly used for shale deposits.

Steam shovels are employed for sandy clays or soft shales at some localities in the United States, but most shales are mined by blasting, and the fragments thus loosened are sent to the works.

Where the clay is rough, and the face of the bank 12 or 15 feet high, a plan often followed is to undermine it by picking at the base, and then inserting large wooden wedges at the top. This brings down a large mass at once, the fall serving to break it up. While effective, this method is often attended with danger.

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*This does not include the mining of kaolin, which is treated separately.

MINING OF KAOLIN.

Kaolin is usually sufficiently soft in nature to be mined by means of the pick and shovel. In some portions of the beds near Valley Head streaks of *halloysite* are found in the clay, which are quite hard, but they are of such a limited extent as not to cause much extra trouble. If the deposit is deep, narrow, or interbedded with other formations which are too thick to be removed by stripping, or if again the kaolin does not run regular in its composition, it is often advisable to follow the better portions of the bed, or the narrow vein if it is such, by means of shaft, levels, or slopes. These sometimes have to be timbered, at other times, as at Valley Head, they do not.

In the case of deposits which are large and broad, it is most economical to operate them as quarry workings or open pits, digging out the material and loading it on the cars or wheel-barrows which convey it to the washing plant. If a pit is large and broad the sides, instead of being dug out vertically, should be left in benches to prevent the washing down of the bank.

In North Carolina, where most of the kaolin deposits are vein formations whose depth is comparatively great as compared with their width, the method adopted is to sink a circular pit in the kaolin about 25 feet in diameter. As the pit proceeds in depth it is lined with crib work of wood, and this lining is extended to the full depth of the pit, which varies from 50 to 100 or even 120 feet. When the bottom of the kaolin has been reached the filling in of the pit is begun, the crib work removed from the bottom upward as the filling proceeds. If there is any overburden this is used for filling in the pit, and as soon as pit is worked out a new one can be sunk in the same manner right next to it. In this way the whole vein is worked out, and if the deposit is large, several pits may be sunk at the same time to increase the output of the mine.*

Hydraulic mining has been tried with some success in some very sandy loose-grained kaolins, but it would not work in any of the deposits in Alabama, which the writer has thus far examined. The method to state it briefly, consists in washing the clay down into the bottom of the pit whence it is sucked up by means of a pump and discharged into washing trough from the conveying pipe, it being sometimes necessary to have a scraper to stir or loosen up the clay in order to permit its being drawn up more easily. This is a cheap and rapid methed where it can be employed, but most kaolins are too dense and not sandy enough to allow of its being used.

THE WASHING OF KAOLINS.

As has already been stated, most kaolins have to be washed before shipment, and one of two methods may be employed, i. e. washing in tanks or troughing. With the first method or that of washing in tanks, the kaolin is thrown into large circular tubs filled with water, in which it is stirred up by means of revolving arms and the clay lumps thereby disintegrated. By this treatment the fine kaolinite particles as well as very fine grains of mica, feldspar, and quartz remain suspended in the liquid while the coarser grains settle on the bottom of the tank. The water with the suspended clay is then drawn off to the settling tanks.

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*H. Ries, Clay Deposits and Clay Industry in North Carol'na Bulletin No. 13, N. C. Geol. Surv., p. 54.

A modification of this consists in the use of a large cylinder closed at both ends and set in a horizontal position; through this cylinder passes an axis with iron arms, the revolution of the latter serving to break up the clay, which is discharged through a hopper at the top. A current of water passes through the cylinder and carries the fine clay particles with it while the coarse ones are left behind in the machine. The speed of the current has to be regulated by experiment, for if too much water is used coarse material will be washed out of the cylinder, and conversely, if the current is too slow the clay will not yield a sufficient percentage of washed product. One objection to this apparatus is that it has to be stopped from time to time to remove the coarse sand from the machine.

The method most commonly used at the present day for washing kaolin, is by troughing and its general detail is as follows:

As the kaolin comes from the mine it is generally discharged into a log washer, which consists of a semi-cylindrical trough in which there revolves a horizontal axis, bearing short arms. The action of these arms breaks up the kaolin more or less thoroughly, depending on its density, and facilitates the subsequent washing. The stream of water directed into the log washer sweeps the kaolin and most of the sand into the washing trough, which is about 15 inches wide and 12 inches deep. It may be wider and deeper if the kaolin is very sandy; in fact it should be. The troughing is about 700 feet long, and to utilize the space thoroughly, it is broken up into sections, 50 feet to each is a good length, these being arranged paralleled, and connected at the ends, so that the water, with suspended clay, follows a zigzag course.

This troughing has a slight pitch which is commonly about one inch in twenty feet, but the amount of pitch depends upon the kaolin, and whether the sand which it contains is fine or coarse. If the kaolin is very fine, and settles slowly, the pitch need not be so great and vice versa. A large quantity of very coarse sand in the kaolin is a nuisance as it clogs up the log washer, and upper end of the trough more quickly and causes so much more labor to keep them clean. As it is, considerable sand settles there, and, to keep the trough clear, sand wheels are used. These are wooden wheels bearing a number of iron scoops on their periphery, as the wheels revolve these scoops catch up a portion of the sand which has settled in the trough, and as each scoop reaches the upper limit of its turn on the wheel, it, by its inverted position, drops the sand outside of the trough. These sand wheels are an aid, but it is often necessary, in addition, to keep a man shoveling the sand from the trough.

If the sand is finer it is not dropped so quickly, but is distributed more evenly along the trough, and does not clog it up so fast.

The zigzag arrangement of the troughing has been objected to by some, as it produces irregularities in the current causing the sand to bank up in the corners at the bends, and also at certain points along the sides of the troughing.*

The effect of this is to narrow the channel, and consequently to increase the velocity of the current, thereby causing the fine sand to be carried still further toward the settling tank. This difficulty, which is not often a serious one, has been obviated either by having the troughing longer or by allowing the water and suspended clay, as they come from the log washer, to pass through a section of straight trough, and from this into another one, of the same depth but five or six times the width, and divided by several longitudinal partitions. The water and the clay then pass into a third section, twice as wide as the second, and divided by twice the number of longitudinal divisions.

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*E. Hotop, Thonindustrie Zeitung, 1893.

By this means the water moves only in a straight course, but as it is being continually spread out over a wider space it flows with an ever decreasing velocity.

By the time the water has reached the end of the troughing, nearly all of the coarse grains have been dropped and the water is ready to be led into the settling vats, but as a further and necessary precaution it is discharged on to a screen of one hundred meshes to the linear inch, the object of this being to remove any coarse particles that might possibly remain, and also to eliminate sticks and other bits of floating dirt that are sure to find their way in.

Two kinds of screens can be used, (1) stationary, and (2) revolving.

The stationary screen is simply a frame with a copper cloth and set at a slight angle. The water and suspended kaolin fall on the screen, and pass through. A slight improvement is to have two or three screens which overlap each other so that whatever does not get through the first will fall on the second. If the vegetable matter and sticks are allowed to accumulate, they stop up the screen, and prevent the kaolin from running through, consequently the stationary screens have to be closely watched.

The revolving screens are far better for they are self cleaning. Such screens are barrel shaped, and the water, with the kaolin in suspension, is discharged into the interior and passes outward through the screen cloth. As the screen revolves, the dirt caught is carried upwards and finally drops; but instead of falling down upon the other side of the screen, it falls upon a board, which diverts it out upon the ground.

The settling tanks, into which the kaolin and the water are discharged, may be and often are about eight feet wide by four feet deep, and fifty or more feet long. As soon as one is filled the water is diverted into another.

The larger a tank, the longer will it take to fill it, and allow the kaolin to settle, and delays due to this cause them to be expensive, especially when the market takes the output of washed kaolin as soon as it is ready.

Small tanks have the advantage of permitting the slip to dry more quickly, especially when the layer of clay is not very thick, and furthermore a small pit also takes less time to fill and empty, but one disadvantage urged against a number of small tanks is that a thorougly average product is not obtained owing to the thin layer of settlings and the small amount in each. In addition to this a series of small tanks requires considerable room.

The advantages claimed for large tanks are that the clay can be discharged into any one for a considrable period, and, if the clay deposit varies in character, the different grades get into one tank and a better average is thereby obtained.

If the kaolin settles too slowly, alum is sometimes added to the water to hasten the deposition. When the kaolin is settled, most of the clear water is drawn off, and the cream like mass of kaolin and water in the bottom of the vat is drawn off by slip pumps and forced by these into the presses.

The presses consist simply of flat iron or wooden frames between which are flat canvas bags. These bags are connected by nipples with a supply tube from the slip pumps, and by means of the pressure from the pumps nearly all of the water is forced out of the kaolin and through the canvass.

When all of the water possible, is squeezed out the press is opened and the sheets of semi-dry kaolin are taken out. It is then dried either on racks in the open air or in a heated room.

As for every ton of crude kaolin usually only about two-fifths or one-fourth of a ton of washed kaolin is obtained, it is desirable to have the washing plant at the mines, for it avoids the hauling of 60 to 70 per cent. of useless sand which has to be washed out before the kaolin can be used or even placed on the market.

II.

GEOLOGICAL RELATIONS OF THE CLAYS OF ALABAMA,

By Eugene A. Smith, Ph. D.

The basis of all clays is kaolinite, the hydrated silicate of alumina resulting from the chemical decomposition of alumina bearing minerals which occur as essential constituents of igneous rocks. In this decomposition, as Dr. Ries has shown, the soluble constituents are leached out while the kaolinite remains behind as an insoluble residuum, more or less mixed with the other insoluble matters of the original minerals.

In this form the clay might be called a chemical clay, since it is the direct result of a chemical decomposition, having undergone no further modification by being taken up, transported and redeposited.

There is another form of residual clay which may be distinguished from the above, and that is the clay resulting from the decomposition of impure limestone. Naturally this variety is usually less free from foreign matters than the other.

These residual clays taken up and redeposited by running waters are incorporated in the stratified deposits of any later age.

The clay deposits of the different geological formations of Alabama have each its well marked peculiarities, and the geological formations are clearly defined, so that an account of the geological relations of these clays becomes a guide at once to the several varieties, and to their geographical distribution.

ARCHAEAN AND ALGONKIAN.

These two formations include in Alabama all the crystalline rocks of both igneous and sedimentary origin. It is generally acknowledged that kaolinite, which is the basis of all clays, has its origin in the decomposition of the minerals composing the igneous rocks, the chief kaolinite producing mineral being feldspar. It is. therefore, in the area of our crystalline or metamorphic rocks that we are to look for the original deposits of kaolinite. More especially, it is the granites, the *pegmatites or graphic granites,* that occur the largest proportion of feldspar, and consequently yield the largest proportion of kaolinite, and of the granites, the*pegmatites* or *graphic granites,* occurring in veins which traverse the other crystalline rock, are by far the most important in this respect.

The clays occurring in this form have been spoken of by Dr. Ries as vein clays, and they are, as a rule, very slightly plastic, for the reason that they have not been subjected to the comminuting processes necessary to develop the highest degree of plasticity.

A belt of mica schists with frequent veins of pegmatite, extends from Cleburne county and adjacent parts of Randolph, through Clay and Coosa into Chilton county, and in numerous places, the decay of the granite veins has given rise to the formation of deposits of kaolinite. The other two constituents of these granites, viz., quartz and mica, occur like the feldspars in large masses, and thus the places which produce mica in large sheets are at the same time the places where the kaolinite is to be found. Below a certain depth from the surface the feldspar of these granitic veins has escaped the action of the atmosphere, and is in its original form, while nearer the surface it has generally been converted into kaolinite. It is evident that in all these primary or original deposits the kaolinites mixed with the other and less destructible constituents of the granite, viz., the quartz and the mica, and by consequence all the kaolinite from such original deposits must be washed to free it from these substances. When the granite or granitic rock contains comparatively little of iron-bearing minerals the resulting kaolinite will be correspondingly free from iron stain and of pure white color, and thus suitable for the manufacture of the finer grades of stone ware or china.

All the important deposits of this kind are, at the present time, at a distance from any railroad, and none of them have been developed in a commercial way. We have at hand very few analyses and tests made of these kaolinites. A material of this kind from near Louina in Randolph county was analyzed many years ago by Dr. Mallett for Prof. Tuomey, with the following result:

Analysis of Kaolinite from Louina, Randolph Co.

Silica	37.29
Alumina	31.92
Ferric Oxide	trace
Potash, Lime and Magnesia	0.72
Water	15.09
Undecomposed Mineral	14.28

Prof. Tuomey remarks upon the absence of iron in this kaolinite as most favorable to its use in making fine porcelain ware, and he predicts that when Randolph county has communication by railroad with the outside world, the occurrence of porcelain clay in the county will become a matter of economic importance.

These pegmatite veins with their mica and kaolinite, are very numerous in the upper half of Randolph county, and also in the adjacent parts of Cleburne and Clay, and test pits have been sunk in hundreds of places to show up both the kaolinite and the mica. Dr. Caldwell of the Elyton Land Company, had this kaolinite thoroughly tested both as to its suitability for the manufacture of porcelain ware and as to its refractory character. The pottery ware made from it came in competition with the best pottery wares in America and took a prize at the Art Institute Fair in Philadelphia, in December, 1890. Brick made from it also was subjected to the highest temperature of the furance and was declared practically infusible. These deposits lie near Milner, Pinetucky, Micaville, in Randolph, and near Stone Hill, Mr. Jas. Denman's and other places in Cleburne. The same belt extends southwestward through Clay and Coosa into Chilton, and has been tested at various places along this line.

In this region of the crystalline rocks, one may everywhere observe the gradual transition from the solid rock through decayed schists into complete soil, which is generally a clayey loam, more or less stained wih iron. A reddish clay is thus seen to be a part of the residual matters left by the general decay of the rocks of this section, but this clay is, as a rule, so much mixed with quartz, mica, fragments of undecomposed rock, that it can serve very seldom for anything more than material for the manufacture of building brick. Residual clays of this character are of universal occurrence throughout the region of our crystalline rocks.

It is not difficult to understand how under certain conditions, the finer portions of these residual clays may be taken in suspension in running waters and redeposited at greater or less distances from their place of origin in depressions, or along slopes. In this way are often formed secondary deposits of pretty fair plastic clays, sometimes mixed with sand in proportion to serve well as material for good building brick. An illustration of this may be cited near Wedowee in Randolph county, and there are many instances where the residual clays of the country as well as these redeposited masses are utilized both for the manufacture of buildings brick of excellent quality, and for pottery purposes.

CAMBRIAN AND SILURIAN FORMATIONS.

In these formations, the clay deposits are either the residual clays left from the decomposition generally of the great limestone formations of the Cambrian and Silurian, or concentrations of these residual clays by redeposition in sink holes, ponds, and depressions; or the accumulation through sedimentary action ,in the depressions of these later formations, of the chemical or vein clays of the Archaean.

The two great limestones, above mentioned, are rarely pure but are mixed with chert or other form of siliceous matters, with iron, and with clay. Upon their decay under the action of the atmospheric agencies, these insoluble matters are left in the form generally of reddish loam or clay capped with cherty fragments, and impregnated with iron.

Such residual clays are extensively used in all our valley regions for the manufacture of ordinary building brick, for which they are very well adapted, the brick being very durable, but not very sightly, since they are likely to be spotted where the clay contains more iron than the average. Occasionally, however, we find as result of subsequent rearrangement by leaching, concretionary action, or the like, these residual matters differentiated from each other in a most remarkable way, so that beds of nearly pure white clay lie alongside of beds of brown iron ore, itself remarkably free from either clay or chert. The most notable of such instances is at Rock Run where the bed of white kaolin, analysis of which is given in the body of this report, No. A. S., forms one of the walls of a bank of limonite which has for years furnished ore to the furance. In close juxtaposition to the ore and kaolin, here mentioned, is one of the beds of bauxite for which this region is well known. Kaolin beds of this residual nature are known in many other parts of the State, resting upon the Cambrian and Silurian limestones. Near Jacksonville, in Calhoun county, at Tampa in the same county, and in numerous other localities of similar nature, are limited beds of kaolin, none of which, however, have as yet been developed or worked.

The following clays described below may be assigned to these formations; the china clays, No. 190, from near Gadsen and No. 205 from Kymulga; the fire clays, No. 191 from Peaceburg in Calhoun county and No. 127 from Oxanna in the same county; the stoneware clays, No. 204 from Blount county and No. 192 from near Rock Run.

In most of the large limonite banks of the valley regions, these deposits of pure clay occur, usually known as clay horses, some of them are undoubtedly of sufficient extent to be of commercial value. Many references to these may be found in the Report on the Valley Regions.

While none of these clay deposits have as yet found a market, it may be well for the sake of completeness to give a few details concerning such as have been recorded. The references to the pages of the report on the Valley Regions, Part II, are also added.

In connection with beds of limonite in S. 31, T. 24, R. 11 E., in *Bibb county,* mention is made of the fact that the ore lies imbedded in clay of red or yellowish red color, with streaks of a white clay (p. 495.)

In Talladega county, in the flatwoods, lying along the line of the Columbus & Western Railroad, in the southeast corner of S. 2, T. 21, R. 3 E., a white plastic clay which is said to have been penetrated to a depth of 35 feet, is reported to have been struck in a well. (p. 606.) In the same county in S. 19, T. 19, R.5 E., in the Charlton limonite bank there is a large "horse" of white clay, extensive deposits of white clay are noticed in connection with other limonite banks in the immediate vicinity. (p. 616.)

In *Calhoun county,* in T. 15, R. 8 E., and in Sections 21 and 23, there are many diggings in beds of limonite, and in most of them are "horses" of white clay, (p. 702). Again in T. 14, R. 8 E., in the same county, near Tampa, on land belonging to A. H. Tullis, Section 6, in the red residual clays derived from the disintegration of the limestones of the county, along with barite and limonite in pockets, are found some deposits of kaolin of white color and considerable thickness, up to 10 feet. In Section 5 of same township and range, the kaolin is exposedd in a cut of the East and West Alabama Railroad where it is 10 feet thick. (p. 715.)

In *Cherokee county*, to the northward of the line of the Southern Railroad in Sections 1 and 2 of T. 12, R. 11, E., there are many banks of limonite which have been extensively worked, and in some of them beds or "horses" of white clay have been exposed. One of these in the Clay limonite bank, in Section 2, the clay deposit is of great extent and several car loads have been taken from it and shipped to Chattanooga for manufacturing into fire brick. A similar white clay occurs in the Hickory Tree bank in Section 1, (p. 759.) The occurrence of the clay in the Dyke limonite bank, near Rock Run, is described on page 777. This is the kaolin whose analysis is given below under the number A. S. In the Washer bauxite band in S. 35, T. 12, R. 11 E., near Rock Run, and in the Warwhoop and other bauxite banks of the same vicinity, white clay and halloysite are of common occurrence. Some of these clays should be utilized.

Some details concerning them are to be found in the Valley Regions report, pages 780 to 789.

In the limonite banks to the eastward of Tecumseh furance in the same county, in T. 12, R. 12, E., clay "*horses*" are everywhere found separating the pockets of limonite, pages 792 and 793.

Accumulations of good plastic clay, which have evidently been deposited in the depressions of the limestone or in ponds, are not uncommon in the area of the great limestone formations. One such near Oxford in Calhoun county, is utilized by the Dixie Tile and Pottery Company. Analysis and physical tests of this clay are given in the body of this report.

Of less purity on account of mixtures of sand, etc., similar deposits are numerous, and utilized in places, as, for example, the brick clay at DeArmanville in the Choccolocco valley.

SUB-CARBONIFEROUS FORMATION.

In the Sub-carboniferous formation of Wills' Valley is found the best known deposit of pure white clay of this section.

This clay occurs chiefly in the lower strata of the formation, generally very close above the Devonian Black Shale. The deposits which have, up to the present time, been pretty well proven, are to be found in the upper or northeastern end of Wills' Valley, near the Georgia line, and on both sides of the valley. The most important of them, however, occur on the eastern side of the valley. They have been .described somewhat in detail by McCalley in Part II of his Valley Regions report, pages 175 to 182, from which the following details are compiled:

The Red Mountain ridges, made up of the strata of the Clinton, Devonian (Black Shale), and Sub-carboniferous formations, occur here as elsewhere in the State, on both sides of the valley. The ridge on the western side is, in general, lower and less continuous than that on the eastern side. The clay occurs in the lower strata of the Sub-carboniferous, not far above the Black Shale, and it has been "prospected" and found to be present in the ridges on both sides of the valley for some ten or twelve miles from the State line southward.

In the northwest corner of S. 3, T. 6, R. 9 E., on the west side of the valley, a test pit exposes the following section:

Section on west side of Wills' Valley, DeKalb Co.

Chert ledge weathered into a sandy rock of yellow color	8 to 12 inches.
Strata hidden by debris	2 to 3 feet.
White clay, without grit, in places like halloysite	3 feet.
Bluish colored clay	3 feet,
Strata not exposed	25 to 30 feet.
Devonian Black Shale	

The white clay occurrs in many places in this vicinity, and is called *chalk* by the people.

On the eastern side of the valley, the Red Mountain ridge, as stated above, is more prominent and continuous than on the west. Near the State line, about Eureka station and thence southwestward for a couple of miles, the clays have been tested and in many places worked. They have a thickness aggregating about 40 feet, but are said to thicken up occasionally to 180 to 200 feet, of which as much as 60 feet is a fine white clay suitable for the manufactory of stone ware. Some of the clay is shipped from here to the potteries at Trenton N. J., and some of it goes to Chattanooga, Tenn. *The Franklin (Ohio) Company Mines* are situated in the northern corner of S. 34, T. 4, R. 10 E. The clay is won by surface diggings, slopes, and tunnels, according to locality.

The following section is obtained along the wagon road through the surface diggings and will give a fairly correct idea of the occurrence.

Section at Franklin Company's Mines, DeKalb Co.

Alternations of chert layers, 4 to 18 inches thick, with fine sharp siliceous powder of white and yellow color	**12 feet.**
Chert of light yellow color, interlaminated with thin streaks of clay	**12 feet.**
Clay, mostly of yellow color, but with seams of white clay	**10 feet.**
Alternations of chert in layers of 2 to 8 inches thickness with clay seams 18 inches in thickness	**4 feet.**
Alternations of chert in layers 2 to 6 inches thick with white clay in irregular seams 6 to 12 inches thick	**18 feet.**
Clay, very gritty, of white color and chalky appearance	**10 feet.**
Clay and shale, the clay white and gritty, the shale green	**10 feet.**
Devonian Black Shale	

In these mines in the upper twenty feet the clay is more siliceous than in the lower twenty feet. The siliceous clay is better suited for making fire brick, while the plastic clay is a potter's clay, commanding a good price. The chert which is interstratified with the clay is also of value in the manufacture of stoneware.

In the N. E. ¼ of the S. E. ¼ of S. 4, T. 5, R. 10 E. are the *Montague Clay Mines,* worked by a tunnel on the southeastern side of the ridge. The clay is about thirty feet in thickness, some of it having a brown coloration, due to organic matter. It is quite uniform in composition for a distance for at least a mile in a northeast and southwest direction, is quite free from stains of iron but perhaps less plastic than the clay from some of the other localities near by. Most of the clay here mined goes to Chattanooga for the manufacture of fire brick. Two analyses of the clay from these mines are given by Dr. Ries under the numbers 116 and 117 and they are classed by him as fire clays.

Further southwest, along the ridge, we find other occurrences of the clay as in the S. W. ¼ of the N. W. ¼ of S. 12, T. 6, R. 9 E., where there is an old opening on a clay bed, which shows some four feet of clay. Still further southwestward in the N. W. ¼ of the S. E. ¼ of S. 15, T. 6. R. 9 E., there are numerous surface diggings, and tunnels in a clay bed thirty feet or more in thickness. Some of the clay of this deposit is of most beautiful quality, and especially well suited to the manufacture of the finest stone ware. A set of china ware, 700 pieces, made from this clay took a premium at the New Orleans Cotton Exposition.

In places the clay has streaks and stains, due to iron, and in other places it has a dark gray color, due to the presence of organic matter, which does not prevent its burning to a white color. Much of the clay is adapted to the manufacture of fire brick as shown by the analyses of a sample collected by Dr. Ries, number 119. Analysis, number 214, shows the quality of the purer and whiter variety.

The clay deposits extend to within two or three feet of the Devonian Black Shale, thus fixing the occurrence at the base of the Subcarboniferous formation.

Beds of potter's clay of this formation have also been noted at other localities, among them one in the railroad cut just north of Stevens' switch on the A. G. S. R. R., and another in Calhoun county in S. 19, T. 15, R. 6 E.*

Hard white clay, like halloysite in appearance, has also been noticed at points in the Tennesseee valley, near Stevenson, and it is quite probable that search in that valley would be rewarded by the finding of deposits of the clay of commercial importance.

COAL MEASURES.

In some parts of the coal fields, the under clays of the seams of coal have been utilized in the manufactory of pottery, as at Jugtown, near Sterritt, in St. Clair county; at Fort Payne and Rodentown, in De Kalb; at Vance's Station, in Tuscaloosa county; at Summit, in Blount county, and at Arab, in Marshall county. In all these places the clay is manufactured into jugs, flower pots and similar articles, while at Fort Payne it is also used in the manufacture of fire brick.

The shales of this formation are also utilized in some parts of the State, notably at Coaldale, where they are made into vitrified brick for paving purposes. At the Graves Coal Mine, near Birmingham, occur two bodies of shale, which have been analyzed and otherwise tested for this report, and the results of these tests are to be found below, numbers 170 and 171.

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*Valley Regions, Part II., pages 441 and 741.

Dr. Ries has tested also the Carboniferous shales from near Pearce's Mill, in Marion county, and finds them admirably suited for the manufacture of pressed brick and with a mixture of a more plastic clay suitable for the manufacture of terra-cotta (No. 3.) Up to the present time none of the clays from the Coal Measures have been found suitable for use in the manufacture of high grades of fire brick, but this may be due to the circumstance that very few of these clays have beeen examined. Of shales suitable for making vitrified brick, there is the greatest abundance.

CRETACEOUS FORMATION.

In many respects the most important formation of Alabama in respect of its clays, is the lowermost division of the Cretaceous, which we have called the Tuscaloosa. The strata composing this formation are prevalently yellowish and grayish sands, but subordinated to these are pink and light purple sands, thinly laminated, dark gray clays holding many well preserved leaf impressions, and great lenses of massive clays varying in quality from almost pure white burning clays to dark purple and mottled clays high in iron.

This formation occupies a belt of country extending from the northwestern corner of the State, around the edges of the Paleozoic formations to the Georgia state line at Columbus. Its greatest width is at the north-western boundary of the State, where it covers an area in Alabama thirty or forty miles wide and about the same width in Mississippi.

From here towards the southeast the breadth of the belt gradually diminishes, till at Wetumpka and thence eastward to the State line, it forms the surface along a belt of only a few miles width.

To the eastward of the Alabama river, the proportion of clay to the rest of the strata is less than in the other direction, and at the same time the clays themselves are as a rule more sandy. But from the Alabama river northwestward, in the gullies, ravines, and railroad cuts, there are many exposures of these beds, exhibiting sections of clay beds from six to forty or fifty feet in thickness, and of varying degrees of purity. In a general way we may say that the purer clays, resmbling kaolin in composition, have as yet been found only in the northern part of this area in Fayette, Marion, Franklin and Colbert counties, and the adjoining parts of Mississippi.

In my Coastal Plain Report, published in 1894,* I have brought together many details concerning the Tuscaloosa formation in the counties of Lee, Russell, Macon, Elmore, Autauga, Chilton, Perry, Bibb, Tuscaloosa, Pickens, Lamar, Fayette, Marion, Franklin and Colbert, and the reader is referred to that book for full discussion of the formation.

In order, however, to present the clay occurrences as completely as possible I shall give extracts from the Coastal Plain Report in so far as they may be descriptive of the deposits of clay.

To these extracts are added a number of details received from a report made by Dr. George Little, who in 1891, spent several months making for the Geological Survey ,some examinations of the clays of this formation. Dr. Little brought together a large collection of the chief varieties of these clays and from these specimens, many of the analyses found in the report below have been made.

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*Pages 307-349, 531-2, 536, 541, 545, 549 551, 556, 559.

Use is also made of manuscript notes of my own on examinations made since 1894 and of descriptions of clay occurrences in the report on the Valley Regions, Part I, by McCalley.

Inasmuch as the remarks of Dr. Eugene W. Hilgard on the clays of Mississipppi apply in general to the clays of this State which lie immediately adjacent to them on the east, a short extract from his Report on the Geology and Agriculture of Mississippi will not be out of place. These notes relate to the clays occurring in Townships 4, 5 and 6 in Tishomingo county, Mississippi, and were published in Dr. Hilgard's Report on the Geology and Agriculture of Mississippi, 1860.

"A large deposit of white clay of great purity, however, occurs in Tishomingo county, chiefly in the southern portion of the territory of the Carboniferous formation, following very nearly its western outline. It there forms a regular stratum of considerable extent, which in one locality at least, was found to be more than 30 feet in thickness. The bed attains its best development, so far as the quality of the material is concerned, in the northern portion of Township 5 and in Township 4, Range 11 east, where it is about 30 feet underground in the uplands, though at times appearing in limited outcrops on the banks of the streams. Northeastward and southwestward from the regions mentioned, the bed also occurs but changed in character, at least near the surface, to a white gritty hardpan, or clays of various colors and of much less purity. It forms the lowest visible portion of the Orange Sand formation, and is almost invariably overlaid by strata of pebbles and pudding stone, which in their turn are sometimes overlaid by common orange-colored sand.

The most southerly exposure of these beds, known to me, occurs on a small branch of McDouglas' Mill creek, in Sections 5, 4, and 9, Township 6, Range 10, east, near Mr. Pannel's place. For more than a mile along this branch there are exposures in which about 20 feet of a whitish mass, varying from a fine clayey sand to a white plastic clay, appears overlaid by thick beds (20 to 40 feet) of ferruginous pebble conglomerate; the latter in its turn being overlaid by the common ferruginous sand and brown sandstone on the hilltops. Similar outcrops appear in the neighborhood of Mr. Aleck Peden's place on Sections 3 and 27 ,Township 5, Range 10 east, northeast of Pannel's Here also a white stratum of which only a few feet are exhibited is overlaid by pebble conglomerate, and this by the common Orange Sand. The white mass varies from white plastic clay to fine grained aluminous sandstone; its upper layers are sometimes composed of a singular conglomerated mass, consisting of small, white quartz pebbles imbedded in pure white pipeclay. In both localities, copious springs of pure water are shed by the impervious clay strata. At Mr. Peden's, there is a fine bold chalybeate spring which seems, however, to derive its mineral ingredients (sulphates of iron and magnesia and common salt) from the adjacent Carboniferous strata rather than from those of the Orange Sand. In either of the localities mentioned, materials suited for fine pottery, or queenware, might be obtained.

Thence northwest, the stratum is not often found outcropping, but, as had been stated, 20 to 30 feet below the surface of the uplands; the country being but slightly undulating. At Dr. Clingscale's, Section 8, Township 5, Range 11 east, the clay stratum was struck at the depth of about 30 feet beneath sand and pebbles; it was dug into, without being passed through, for nearly 30 feet more, no water being obtained from below, but dripping in above from the base of the pervious strata. The whiteness and plasticity of the material seems to increase with the depth. The portion of what was dug out of the well in question, had already been removed at the time of my visit, having been used for various economical purposes as, chalk, whitewash, and "Lily White". The specimens examined were, therefore, rather below the average quality, and on long exposure to the air, their surface shows some yellowish spots. I found nevertheless, that in baking at a high heat they yielded a biscuit of greater whiteness than their natural color when fresh; and that fine splinters, exposed for ten minutes to the highest heat of the mouth blowpipe, retained their shape perfectly while reduced to a semi-transparent frit. A quantitative analysis of the clay from Clingscale's well gave the following results:

White Pipe Clay from Clingscale's.

Insoluble matter	90.577
Lime	0.140
Magnesia	trace
Peroxide of iron	0.126
Alumina	2.211
Water	6.930
	99.864

This analysis (which was made solely for the purpose of ascertaining the ingredients foreign to the clay proper) proves the singular fact that this clay, though occurring in a formation characterized by the large amount of iron it commonly bears, contains a remarkably small amount of that substance, which, together with minute porportions of lime and magnesia, explains its infusibility.

The two most important practical purposes which the materials occurring in the deposits just described will serve, are the manufacture of fine queenware and that of fire proof brick. (Not porcelain. Kaolin or porcelain earth contains, besides the white clay, a certain amount of undecomposed feldspar, which imparts to it its property of being semi-fused at the temperature of the porcelain kiln. The same property might be imparted to the white clay in question, by the artificial admixture of ground feldspar, but it could not thus compete with the naturel kaolin of Alabama).

As for the queenware, the plasticity of the material leaves nothing to be desired; and since the amount of siliceous matter varies greatly in different layers, there could be no difficulty about givng to the mass the precise degree of meagerness which may be found most advantageous, by mixing the several successive layers. The same may be said with reference to the manufacture of fire brick (to which these materials are admirably adapted), which would probably, at the present time, be the most feasible and most profitable manner in which the beds could be made available. The manufacture of fire brick differs from that of ordinary brick in this, that it requires more care, both in working the clay and in moulding the brick. Beyond their fireproof quality, it is demanded of fire brick *that their shape be perfect, their mass uniform and without flaws in the interior;* also that they shall be liable to *the least possible shrinkage* in a high heat. The latter quality is imparted to them by a considerable mixture of either sand or ground fire brick to the fireproof clay, which itself ought to be thoroughly seasoned before, and then well worked up with such additions of the above materials as may be required. In judging of the amount of sand or ground brick to be added, it is to be observed, as a rule, to add as much as may be consistent with the proper firmness of the burnt brick and with convenient moulding. The latter process ought to be performed, as in the manufacture of pressed brick, whenever a first-class article is aimed at, for it is only thus that external and internal flaws are entirely avoided. In some localities materials may be probably found which require no further admixture—the strongly siliceous varieties of the clay; but whenever sand or burnt clay is added to the mass, care should be had that it be free from iron, which would seriously impair the fireproof qualities of the clay. None but white sand should be used. For the rest, they may be burnt in kilns like common brick."

RUSSELL AND MACON COUNTIES.

Within the limits of Girard and Phœnix City, opposite Columbus, and in the hills to the west of Girard, are many exposures of the Tuscaloosa strata, aggregating some 200 feet in thickness. These are composed mainly of sands, but there are numerous beds of white, gray and purple or mottled clays interstratified with the sands. The small stream which flows through Girard exposes a number of these clay beds, and others are to be seen in the hills to the west of the town. The materials for the manufacture of drain pipe, vitrified brick, pressed brick etc., are here in abundance.

These clays are to be seen at intervals along the road leading toward Montgomery, e. g., near Marvyn, Crawford and Society Hill, the prevailing variety being the mottled red or purple clay. Northwest of Society Hill these clays occur as far as Farrell's Mill, in Macon county.

Near Cowles' Station, at the ferry across the Tallapoosa river, purple clays, three feet in thickness, show in the river bank, and a short distance further down the river at the site of Old Fort Decatur, a fine section of the Tuscaloosa beds, including many beds of clay from one foot thickness and upwards is exposed.*

ELMORE AND AUTAUGA COUNTIES.

In the vicinity of Old Coosada town, along the banks of the river, about Robinson Springs and Edgewood, there are many occurrences of the clays of this formation, analyses of which have been made by Dr. Ries, and the results given below in the body of the report. About Edgewood there are several potteries and one ochre mine using the materials of the Tuscaloosa formation. McLean, Vaughn and Boggs have potteries here, and Pressley has one further west.

At Chalk Bluff, near Edgewood, there is a very characteristic section exposed in an ancient bluff of the river, now at a distance of more than a mile from that stream. The section is as follows:

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*Coastal Plain Report, p. 554, 556.

Section at Chalk Bluff, Elmore County.

1.	Layette red loam and pebbles	15 feet
2.	Gray and yellow sandy clays, in distinct but irregular layers	6 "
3.	White clay, 3 feet graduating downwards into yellow ochreous clay, 3 feet	6 "
4.	Gray plastic clay blue when wet, and exceedingly tough and sticky; full of vegetable remains, flattened and bituminized	10 "

Two samples of this clay (Nos. 101 and 122) have been tested and analyzed by Dr. Ries (see below under the head of Pottery Clays and Brick Clays), where a section of this bluff is given, differing slightly from the above. This is not to be wondered at, since the stratification is very irregular, and no two sections, twenty feet apart, are idential.

Along the line of the Mobile and Ohio Ry., in Autagua, and on most of the pubilc roads leading from Prattville north and northwest, there are exposures of Tuscaloosa strata, consisting of sands and clays, the former predominating. In the western or northwestern part of the county, near Vineton, many instructive sections of the Tuscaloosa beds are to be seen. Some of these sections include beds of clay, which are of interest in our present work.

Section, near Col. J. W. Lapsley's place, Vineton.

1.	Stratified clays of white, pink, and purple colors, interlaminated with thin sheets of yellow sands: the lower part of this bed has a larger proportion of sand	10½ feet
2.	Gray laminated clay with partings of purple sands	5 "
3.	Yellowish white laminated clays, with purple and other bright colors on the dividing planes, 5 feet showing, but the same beds appear to continue down the hill for at least ten feet further	15 "

Section No. 2, near the preceding.

1.	Yellowish sands, beautifully cross-bedded....	4 feet
2.	White and pink clays, interbedded with yellow sands	10 "

Section No. 3, same locality.

1.	Purple clays interbedded with reddish sands..	6 feet
2.	Mottled (red and yellow) sandy clays, partly obscured by overlying pebbles and sands......	12 "
3.	Red sands with small lenticular bits of yellow clay......	5 "
4.	White and yellow laminated clays	6 to 8 "

At the bridge over Mulberry, near Vineton, the following strata are shown in the banks of the creek:

Section on Mulberry Creek, near Vincton.

1.	Mottled purple clays, similar to those at Steele's Bluff on Warrior River	5 feet
2.	Yellow cross sandy beds	2 "
3.	Mottled clays sandy below	5 "
4.	Grayish white micaceous sands, with irregular patches of red and yellow colors; to water's edge	4 "

BIBB COUNTY.

From Vineton up to Randolph very little of the strata of the Tuscaloosa formation can be seen until within three miles of the latter place, where dark purplish gray clays are to be encountered. Between Randolph and Centerville, along the public road, and at many points along the railroad from Mapleville to Centerville, there are occurrences of the massive clays of this formation. These clays have given much trouble and caused much expense to the railroad, from the fact that when softened by the winter rains they squeeze out into the railroad cuts, filling them up and overflowing the track. Where the clays from the cuts are used to make embankments, they are equally troublesome, as they are continually giving way. We have no accurate notes of the sections exposed in the railroad cuts but the public road from Randolph to Centerville has been somewhat closely examined. At Soap Hill there is a typical section as follows:

Soap Hill, 7 miles East of Centerville.

1.	Purple and mottled clays at summit of hill...	5 feet
2.	Clayey sands in several ledges	10 "
3.	**Cross bedded yellowish and whitish sands,** traversed at intervals by ledges of sandstone formed by the induration of the cross-bedded sands	30 "
4.	Laminated gray clays with partings of sand..	10 "
5.	Alternations of laminated gray clays with cross-bedded sands in beds of 12 to 18 inches thickness	40 "
6.	Yellowish cross-bedded sands with clay partings	20 "
7.	Laminated gray sandy clays containing a few leaf impressions	10 "
8.	Grayish white sands	8 "

On the same road in the eastern part of the town of Centerville, on the School House Hill, there may be seen some fifteen feet thickness of purple and yellow clays.

The same beds show along the Selma road, south of Centerville, at many points. Sections are given in the Coastal Plain Report, pages 336 and 338. To the southwest of Centerville also, in townships 21 and 22, ranges 7 and 8, many of the ridges are composed of purple clays eight or ten feet in thickness, resting on four to six feet of gray clays.*

On the road to Tuscaloosa the clays show about half way between Centerville and Scottsville.

Along the line of the Alabama Great Southern Railroad in this county, there are many exposures of the Tuscaloosa clays, e .g. at Bibbville, where they have been utilized for many years in the manufacture of semi-refractory fire bricks for grates, etc. A great deal of the material is shipped now to Bessemer, where it is worked up into fire brick. Further north, near Woodstock again are rather extensive diggings on the line of the Birmingham Mineral Railroad, from which the clay is shipped to Bessemer and used as above indicated.

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*Costal Plain Report, page 338.

Dr. Ries has investigated the clays from both of these localities, and his results are given below in the body of the report, under No. 112 for the Bibbville's specimen, and No. 111 for that from Woodstock. He classes them with the fire clays. Another specimen from Woodstock, classed by Dr. Ries as brick clay, has been tested, (No. 126, A. Stevens).

TUSCALOOSA GOUNTY.

The utilization of the clays of this formation was begun in Tuscaloosa county by Daniel Cribbs in the year 1829. He was the pioneer, though it is said that W. D. Preston had a pottery in Autauga county in 1828. C. K. Oliver has had a pottery in this county since 1856. Peter Cribbs, in Lamar county, carried on the business for twenty-five years. He was the brother of Daniel, whose son, Harvey H. Cribbs, has for many years been more or less engaged in working the clays along Cribbs Creek, two miles south of Tuscaloosa, and later four miles east of town on the Alabama Great Southern Railroad. The Lloyd family have operated several potteries in Marion county, Alabama, and Itawamba county, Mississippi, for many years. Fleming W. Cribbs, a son of Peter, has now a pottery at the new town of Sulligent, on the K. C. M. & B. R. R.*

Within the limits of the city of Tuscaloosa there are many exposures of the clays of this formation in the gullies facing the river bottom. In one of these gullies the section is as follows:

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*Notes of Dr. George Little.

Section in Tuscaloosa.

1.	Pebbles, sand, and red loam of the Lafayette forming the plateau on which the city of Tuscaloosa stands	15	feet
2.	Light gray, somewhat massive clays, mottled with yellow, but becoming laminated below	8	"
3.	Dark blue, nearly black laminated clays, laminae half an inch thick, separated by thin partings of white sand. The clay contains leaf impressions	3	"
4.	Yellowish gray laminated clays, also containing impressions of variable thickness, average	2	"
5.	Strongly cross-bedded sands, yellowish to white, sharp, with a few streaks of clay irregularly distributed through it..........	20	"

At the proper depth below the surface, the clays above mentioned are encountered in most parts of the plain, though naturally the thickness of the beds and their character vary from place to place.

Eastward from the city the cuts of the A. G. S. railroad exposes these clays at numerous points. Some four miles from town they have been utilized by Mr. Harvey Cribbs in the manufacture of flower vases, jugs and similar wares. Below about twenty feet of the surface red loam and pebbles, we find at this place one to twelve feet of white clay, free from streaks; then three feet of yellow sand and a bed of blue clay of undetermined thickness.*

D. Ries' analysis and tests of the Cribbs' clays are given below under No. 1, S., where it is classed among the pottery clays.

At the Box Spring, about five miles east of Tuscaloosa, the railroad cuts expose about six or eight feet of laminated gray clays marked with purple streaks. Beyond Cottondale, nine miles from Tuscaloosa, about thirty or forty feet thickness of purple clays seen along the hillside.

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*Notes of Dr. George Little.

Some twelve miles east of Tuscaloosa the grayis purple clays appear in many places along the slop of the hills. The following general section of strat in this vicinity will give a good idea of the formatio

Section 10—12 miles East of Tuscaloosa.

1.	Purple massive clays	5 feet
2.	Ferruginous sandstone crusts	6 to 8 inches
3.	Variegated clayey sands holding small pieces of purple clay	10 feet
4.	Purple clays with partings of sand	10 "
5.	Ferruginous crust	1 "
6.	Laminated gray and yellow sandy clays	6 to 8 "
7.	Lignite with pyrite nodules	2 to 6 inches
8.	Dark gray somewhat massive clays	6 to 8 "
9.	Strata obscured by debris from above	20 "
10.	Purple clay at base of hill, thickness undermined.	

Along the A. G. S. R. R. beyond Cottondale, th cuts show many varieties of materials of this formation, among them beds of purple clays, sometime massive, sometimes laminated. Just beyond Cottondale the clays gave much trouble many years ago a what was known as the "Sliding Cut."

A mile or two beyond Vance's Station, a bed of thes clays is now being worked for material to use in th manufacture of fire brick at Bessemer.

Southward from Tuscaloosa the clays are seen i most of the hills bordering Big Sandy Creek, an judging from the width of the outcrop along the hillsides there can not be less than fifty feet thickness o them.

The same clays show along the A. G. S. railroad a Hull's Station, and all that vicinity, and Dr. Ries presents an analysis, together with the physical tests of a sample of this clay, No. B., which he classes as refractory or fire clay.

A characteristic section of these clays exposed along the hillsides, just south of Big Sandy, where the Greensboro road passes, is given below:

Section on Big Sandy Creek, Tuscaloosa County.

1.	Purple or mottled clays, like those occurring at Steele's Bluff, on Warrior river	30 feet
2.	Light yellow sands with pebbles, also similar to those seen at Steele's and White's Bluffs	10 to 15 feet
3.	Gray, laminated clay, enclosing a lignitized tree trunk at base of hill	4 to 5 feet

Further south the materials of the Tuscaloosa formation seem to be more sandy, and the proportion of clays is small.

Along the banks of the Warrior river below Tuscaloosa, the clays show up in many places, especially in the vicinity of Saunders' Ferry.

At the Snow place, above the ferry, there are some great gullies, in which these sands and clays of the formation are exposed. In some of the clay beds many leaf impressions have been obtained, which have assisted in the determination of the geological horizon of the Tuscaloosa formation.

A short distance above the ferry, and adjoining the Snow place, there is a bluff about 140 feet high which shows the clays and other beds of this formation very clearly. The section is as follows:

Section above Saunders' Ferry, Warrior River.

1.	Massive clays of greenish and purple colors, breaking with conchoidal fracture. On drying these clays become hard and rock-like. When wet by the winter rains, they soften and slide down the slopes, covering them completely in places. Thickness	40 feet
2.	Laminated sandy clays, gray, with sand partings	5 feet
3.	Gray cross-bedded sands, with partings of clay along many of the planes of false bedding	25 feet
4.	Gray cross-bedded sands and blue micaceous sands	23 feet

At Williford's landing the purple clays show about ten feet in thickness below the second bottom, or river deposits.

At Steele's Bluff, and a few miles below, at White's Bluff, similar purple or mottled clays make about ten feet thickness of the river bluff.

Westward and northwestward of Tuscaloosa the clays appear along all the roads for many miles to the western boundary of the county, and beyond into Pickens. The clays when freshly exposed are of gray color, but undergo a series of changes in consequence of weathering, and the oxidation of the iron which they contain. First, the gray becomes specked with red, and this color gradually increases in proportion until it prevails, and the whole body of clay becomes a dark red or purple mass, with few, if any, of the fragments of the original gray color.

At John Mills', about thirteen miles from Tuscaloosa, on the Shirley Bridge road, the following section is made by Dr. Little:

Section in Tuscaloosa County.

1.	Red loam and sand (Lafayette)............	10 feet
2.	Ferruginous sandstone crust....	6 feet
3.	Blue clay (Sample No. 1)..................	6 feet
4.	Yellow sand, with indurated crust above and below........	7 feet
5.	Blue Clay (No. 2)..........	6 feet
4.	Yellow sand, with indurated crust above and	

On the Fayette Court House road the same clays show at many points, but the most promising clays along this road have been observed beyond the Tuscaloosa county line in Fayette.

The Mobile and Ohio road to the northwest of the city of Tuscaloosa exposes in many of its cuts beds of clay, which have been a source of much trouble and expense house of the filling of these cuts by the softened clay during the winter seasons. Several cuts in the vicinity of Ten Mile Cut have traversed these beds of clay. One specimen from the Ten Mile Cut has been examined by Dr. Ries, and classed among the brick clays (No. A), though, as Dr. Ries remarks, there is no reason why it should not find other uses as well.

In the near vicinity of this cut, on land formerly occupied by Mr. J. C. Bean, occur three beds of clay measuring each about five feet thickness. These have been investigated by Dr. Ries under the Nos. 118, 115 and 100. The first of these, classed as fire clay, has many points of interest, growing out of its dense burning at low temperature, and the great difference in temperature between the points of incipient fusion and vitrification, suggesting its suitability for use as a glass-pot clay. The other two clays are classed as pottery clays, and are perhaps representative of one of the most widely distributed types of the clays of this formation.

PICKENS COUNTY.

Near the line of the M. & O. road, in this county, the clays are observed from the Tuscaloosa county line to within nine miles of Columbus. In mode of occurrence and in the character of the clay these beds resemble those of Tuscaloosa, above mentioned. From Roberts' Mill on Coal Fire Creek, Dr. Little has collected a sample of white clay which has been analyzed by Dr. Ries, No. 32 S. It is classed by him among the stone-ware clays, burning to buff color, and is in many respects similar to the Cribb's clay of Tuscaloosa. West of Coal Fire Creek, and at a distance of 18 to 20 miles from Columbus, the massive reddish clays show in the hills to a thickness of 40 to 50 feet.*

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*Notes of Dr. George Little.

LAMAR COUNTY.

The strata of the Tuscaloosa formation cover the entire area of Lamar below the mantle of red loam and pebbles of the Lafayette. Among the strata are numerous beds of clay of varying degrees of purity. Dr. Little's notes, which follow below, give many details concerning them.

Along the line of the Southern (Georgia Pacific) Railroad, there are many exposures of the clays, as at Millport, where the clay shows at a thickness of four feet; beyond this at about 23 miles from Fayette Court House, the clay seems to be 10 feet thick, and near this at Fernbank, J. D. Green has a pottery. His clay is 18 feet thick, analysis of this clay is to be found in Dr. Ries' report, No. 27 S.

Along the road from Fayette Court House to Vernon, at 9 miles from the former place we have this section.

Section nine miles west of Fayette C. H., in Lamar Co.

Blue clay	6 feet
Mottled clay	20 feet
Sandy clay	4 feet

Three miles further west on the same road, this clay is some 20 feet in thickness. Within two miles of Vernon, in A. W. Nichol's well, blue clay 8 feet thick is penetrated below six feet of overlying sands.

One mile east of Vernon, at a saw mill, there is clay, white and 3 feet in thickness.

On the old military road of Gen. Jackson at a distance of 20 miles from Columbus, Miss., and about 7 or 8 miles northwest of Vernon, near Bedford P. O., are the remains of a pottery once owned by Peter Cribbs. At this place lives Captain Cribbs, a negro man with his son, Major. Captain worked for many years in the potteries, which his master, Peter Cribbs and his master's widow, managed from 1865 to 1886. The pottery, 3 miles further north on the Military road near M. P. Young's, was the place where most of the jugs, jars, etc., were made. The best of the clay for these potteries was obtained from what is now Reuben Powell's land, 2 miles west of the Military road in the northwest quarter of the norhwest quarter of S. 28, T. 14, R. 16. The pits were dug 14 feet down to the clay, which was 3 feet thick. Mr. Powell has bored with an 8 inch augur near this place, and found clay 1½ feet from the surface, 5 feet thick, dark brown and very tough and plastic. Analysis of this clay is given by Dr. Ries under No. 11 S.

Lewis J. Jones, who now lives on the Powell place in the southwest quarter of southwest quarter of Section 23, has bored a well in his yard of which the section is as follows:

Section in Well, Lamar Co.

Surface sands and loams	12	feet
Clay	1½	feet
Sand	9	feet
Clay	2	feet
White sand	24	feet
Clay, penetrated to depth of	2	feet
but so tough that the auger could not be raised, and the well was stopped.		

Clay is also reported at Thomas' Mills, above Hunnel's Bluff on Buttahatchie creek and on Wilson's creek near Friendship Church.

Westward from the Military road, the clay territory continues to within 10 miles of Aberdeen, where level land and white sandy soil set in.

Gattman is on the Mississippi State line, and just west of it across Buttahatchie is Greenwood Springs, 4 miles from Quincy in Monroe county, Mississippi.

One and a half miles south of these Springs, there is a railroad cut 85 feet in depth, the largest cut on the road, (K. C. M. & B.) 110 miles from Birmingham. In this cut we find the following section:

Sections along K. C. M. & B. R. R., Lamar Co,

Yellow loam	5 feet
Yellow sand	15 feet
Yellow sand with streaks of clay	5 feet
Blue micaceous clay, sample No. 11, A	5 feet

Half a mile further west another section:

Yellow clay	5 feet
Ferruginous sandstone, used for ballast	10 feet
Yellow sand	20 feet
Clay with sandy layers	8 feet
Compact blue micaceous clay, sandy	12 feet

At mile post 111, the section is:

Red clay	10 feet
Banded red and white clay	10 feet
Pore, sand	10 feet

Half a mile west of the 111 mile post, the section is:

Red loam of the Lafayette formation	5 feet
Bright yellow sand	30 feet
Clay	2 feet
Light yellow sandy clay	20 feet
Red and white clay	5 feet

Near the State line, on the Kansas City, Memphis and Birmingham Railroad, 3 miles from Sulligent on the west side of Buttahatchie,a pottery has been operated. At Sulligent, Fleming W. Cribbs has lately started a pottery. He is a son of Peter Cribbs and nephew of Daniel Cribbs. His clay bed is one-half mile east of Sulligent and is 4 feet thick, and white. He says that his father carried on the business from 1838 to 1853 when he died, and his widow continued the work to 1863, his account agreeing with that of the negro, Captain, nearly as to time of operation, but placing it in entirely different decades. He has orders now for 5000 gallons (jugs) from Birmingham and Bessemer, at eight cents a gallon. He has two hogback kilns with a capacity of 800 jugs each. His clay is found in a washed out old road and is overlaid by 10 feet gravel.

Rye has a pottery, 6 miles north of Millville, Detroit P. O. Davidson Brothers have one also in same neighborhood. Lloyd has one near the Mississippi line in Itawamba county. These compete with potteries at Holly Springs, Mississippi, and Pinson's 12 miles from Jackson Tenn., for the West Tenn. and Miss. trade. From State line at Gattman to Glenn Allen, clays are very abundant and of fine quality all along the Kansas City Railroad, and this is destined to be an important center of trade in all kinds of clay manufacture. Beaver Creek flows nearly west, parallel with the railroad. Beaverton is a station on Section 17, Township 13, Range 14 west. One mile west of William Brown's place, Section 10, and on Edmund Barnes', Section 16 and on Ira Sizemore's, Section 17, clay abounds. Brown has ten feet blue clay overlaid by 10 feet cross banded yellow sand. 5 miles east of Beaverton and 2 miles west of Guin, there is 10 feet white and yellow sand and underlaid by 3 inches of ferruginous conglomerate.

FAYETTE COUNTY.

Over the greater part of the area of Fayette county, the strata of the Coal Measures are covered, to a depth increasing as we go westward, by beds of the Tuscaloosa formation capped with the red loam and pebbles of the Lafayette. Among the strata of the Tuscaloosa there are many beds of clay of purple, gray and white colors. About the Court House, a bed of white clay is reached at many points below a varying thickness of overlying strata. Thus at Mr. Sam Appling's a bed of fine white clay, 6 feet in thickness, is cut in a well, and apparently the same bed is known to underly the region about the depot. Mr. Appling's is in Section 24, Township 15, Range 13 west.

From Dr. Little's notes, I am able to give a number of details of the occurrences of these clays. Seven miles from Fayette Court House, on the road to McCollum's Bridge, is a bed of three feet thickness of very pure clay ,hard and firm, which breaks up on exposure into nodules, and the same bed shows on another road to the west of this about one mile, south of Wallace's Mill on Gilpin's creek, on W. D. Bagwell's land.

Dr. Ries' analysis of this clay is to be found in the report under number 67, S.

On the road to Pikeville, seven miles from Fayette Court House, we have the following section:

Section seven miles north of Court House, Fayette Co.

Red loam of Lafayette........	2 feet
Gravel........	10 feet
Clay......	3 feet
Gravel......	3 feet

Between the depot and the Court House Dr. Little has observed three feet of good white plastic clay in a ravine on the roadside, and the same bed is exposed in the ravines at many points on the eastern edge of the old town. Five miles west of the Court House on the Vernon road, some tan-yard vats were dug years ago, three feet into a blue clay. About half a mile from the depot, Mr. Joe Lindsay reports fine white clay, twelve feet below the surface, which, he says, was twenty feet thick.

To the westward and southwestward of the town along the line of the railroad, the clay shows in a cut one mile from the depot. On the Columbus road, four miles from Fayette, a six foot bed of clay is recorded, and five miles further west, at Hezekiah Wiggins' a bed of blue clay, four feet thick. Dr. Ries has tested and analyzed this clay under No. 32, S.

Half a mile further west, at Henry Wiggin's, there is a bored well, eighty feet deep, which, below the depth of fifteen feet, seems to be mostly in clay. One fourth of a mile beyond this, near Waldrop's, a bed of blue clay, 10 fet thick, shows at the bottom of a hill, and fifteen feet higher up another bed appears.

Along the road to Tuscaloosa at seven miles from Fayette, and also a mile further on, clay, three feet in thickness, is exposed. Again in section 13, township 17, range 12, about a quarter of a mile from Shirley's Mill, several beds of clay are shown along a hill side. One of these beds, a brown clay, about three feet in thickness, is full of finely preserved leaf impressions. and below it a fine sandy clay of three feet thickness. This is near the 11 mile post from Fayette.

Dr. Ries has analyzed two samples of the clay from this place under the numbers 68, S., and 110, and the reader is referred to these analyses and the remarks of Dr. Ries below.

Two miles southwest of Shirley's Mill on Davis' Creek, J. W. Black reports four feet of blue clay in section 25, township 17, range 12 west.

Near Doty's place, one mile east of Concord Church and about thirteen miles from Fayette, there is the following section exposed in a gully:

Section near Doty's, Fayette Co.

Red loam and sands of the Lafayette	4 feet
Ferruginous sandstone crust	2 inches
White clay (No. 7, Dr. Ries)	6 feet
Yellow sand	5 feet
Variegated clay (No. 71, Dr. Ries)	2 feet
White sand	2 feet
Mottled clay, red and white	8 feet

Dr. Ries' analyses of the two clays here exposed may be seen below under numbers 70 and 71.

MARION COUNTY.

While the strata of the Coal Measures underlie the entire area of Marion county, yet these rocks do not form the surface over any great proportion of this area, since they are very generally hidden, except along the valleys of the streams, by overlying measures of the Tuscaloosa and Lafayette formations. Among the strata of the Tuscaloosa, here as in Fayette, we find many fine beds of clay. Here again, Dr. Little has collected many details of the occurrence of these clays and what follows we take mainly from his notes, though use is made also of what has been published in my Coastal Plain Report, pages 331, 332 and 333.

In the lower part of the county along the line of the K. C. M. & B Railroad, clays are exposed in railroad cuts all the way from Eldridge to Guin.

From New River crossing near Texas P. O., on to Glen Allen, several beds of clay, of no great thickness, are to be seen. A mile east of Glen Allen, in what is known as Stewart's Cut, we have the following section:

Stewart's Cut, one mile east of Glen Allen.

Gray laminated clay with fine leaf impressions...	25 feet
Ferruginous sandstone crust of irregular thickness	1 foot
Cross-bedded sands of yellow and pink colors.....	25 feet

The uppermost of the beds, above named, contains many beautifully preserved leaf impressions which are very easily gotten out. The clay has been examined by Dr. Ries under No. 18, S.

At another cut, half a mile nearer Glen Allen, we find twenty feet of white sand with two feet of white clay, and below this a blue plastic clay extending below the railroad track.

This sand has been shipped to Memphis as moulding sand for the foundry. At Glen Allen, Dr. Little gives this section:

Section at Glen Allen, Marion Co.

Brown clay	12 feet
Yellow sand	12 feet
White pipe clay	2 feet

Two miles east of Guin, on the same road, Dr. Little observes five feet of clay below a capping of red sand, and one mile west of Guin, (six miles from Beaverton) he gives the following section:

Section near Gwin, Marion Co.

Cross-bedded yellow sands	10 feet
Clay	4 feet
Sand	3 feet
Banded clay	3 feet
Sand	3 feet

On the South Fork of Buttahatchie in the vicinity of Pearce's Mill, there are several occurrences of clay and shale worth consideration. Dr. Ries collected specimens from near the mill and gives his analyses of two samples under No. 1 and No. 2, both of which he classes as refractory or fire-clays. He also gives his tests of some shales of the Carboniferous formation, which are well adapted to the manufacture of vitrified brick (No. 3). Another sample of hard and perfectly white clay was collected by Dr. Little from near the top of a hill one-fourth of a mile east of the mill. This Dr. Ries has analyzed under No. 36, S., and it is classed by him as a china clay. Dr. Little reports that, in pulverized condition, it is used as a face powder by the ladies in the vicinity.

It is, however, in Townships 9 and 10 and Ranges 11, 12 and 13, that we find the most important deposits of clay in this county. The typical locality of its occurrence is at *Chalk Bluff*, which gets its name from the white clay. Specimens collected by myself were analyzed by Dr. Wm. B. Phillips and results published in the Coastal Plain report, page 346. Dr. Little's sample was collected on the land of J. J. Mitchell, in northeast quarter of Section 8, Township 10, Range 13, from a bed five feet in thickness. The analysis of this is given below under No. 38, S., and on the same page Dr. Phillips' analysis is reprinted. This locality gives the name to the postoffice. In the same quarter section, Dr. Little has collected a sample from Briggs Frederick's land, and the analysis of this is given by Dr. Ries under No. 37, S.

Another sample from the same locality from land of Mrs. Susan Nelson, has been examined by Dr. Ries (his number 85). The same clay is reported by Dr. Little as occurring southwest of Chalk Bluff at M. E. Gassett's, Section 13. Township 13, Range 10, as well as at a number of localities within a radius of five or six miles around Chalk Bluff. This clay is hard and white, approaching pure kaolin in composition. It is in a bed, five to seven feet in thickness, and needs only facilities for transportation to become one of the most valuable deposits in the State.

Between Pikeville and Hamilton, clays are of frequent occurrence, one of these near the former place and some ten miles from Hamilton, collected by Dr. Little has been analyzed by Dr. Ries, (No. 65, S.)

Westward from Hamilton to the Mississippi line and beyond, Dr. Little reports many occurrences of clay of various qualities. From the vicinity of Bexar, three samples of clay have been collected by

Dr. Little and analyzed by Dr. Ries, (numbers 12, 40 S. and 41 S.). The bed in this region is about four feet in thickness. Nos. 12 and 40 are from H. Palmer's and No. 41 from Bexar, a mile further west, near Pearce's Store and Mill.

Near the State line on the road to Tremont, Miss., twenty feet thickness of clay is reported as being cut in a well.

Beyond the State line, the clays continue, and at Davidson's Store, Lloyd's pottery, they are put to a rather remarkable use, namely for head stones of graves, for which purpose they are moulded into flat tablets, provided with suitable inscriptions and then baked. These stones appear to be quite durable although necessarily liable to be broken.

A number f potteries in this vicinity use this clay which is about four feet in thickness, and quite similar to that mentioned above as occurring about Gattman in Lamar county, on the K. C. M. & B. Railroad.

The Bexar variety of clay extends for a good many miles northward up Hurricane Fork and along Bull Mountain Creek.

FRANKLIN COUNTY.

In Franklin county the underlying Paleozoic rocks of Carboniferous and Subcarboniferous ages are exposed along the valleys of the streams, but everywhere else are covered with a mantle of varying thickness of the sands, clays and pebbles of the Tuscaloosa and Lafayette formations.

As in the other counties adjoining towards the south, so in this, it is in the Tuscaloosa strata that we find the important deposits of clay. In parts of the county, especially in the vicinity of Russellville, valuable deposits of limonite or brown iron ore have been for many years and are now being worked to supply the furnaces at Sheffield and Florence.

Associated with these ore beds are *clay horses,* as they are called, which, in places, yield an abundance of fine white clay.*

Other occurrences of the clays of the Tuscaloosa formation, not associated with the iron ores, have been recorded by Dr. Little, from whose notes the following details have been obtained.

On the southern boundary of the county, near Savoy postoffice, in T. 8, R. 14, near Dr. Kilgore's Mill, a bed of blue plastic clay three feet thick is noted, above which, one hundred feet up the hill, is a bed of four feet thickness of red clay or ochre (red chalk), and just above this a bed four feet thick of pure, hard, white clay, like that of Chalk Bluff, in Marion county. The same beds are to be seen at many points around Savoy within a radius of three miles. Half a mile west of Burleson a bed three feet in thickness of white clay is found immediately overlying the blue limestone of the Subcarboniferous formation. Along the road from Burleson to Belgreen the clay is exposed at several points.

Northwest of Russellville, on the road to Frankfort, large deposits of white clay were reported, but not seen by Dr. Little.

Near the State line, in S. 9, T. 7, R. 15, on Gilley's branch, occurs a bed of clay from which material has been obtained for a pottery formerly worked by Mr. Chaney, two miles east of Pleasant Ridge, Miss.

Southward of this locality, in S. 20 and S. 29, of T. 8, R. 15, Mr. Thomas Rollins has a bed of clay four feet in thickness, a sample from which has been tested by Dr. Ries, No. 62 S. The country for several miles in all directions about Rollins' is rough and hilly, the hills capped with beds of pebbles and a ferruginous sandstone crust, but the beds of clay, interstratified with sands, seem to make up a very considerable proportion of their bulk.

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*Valley Regions Report, Part I, pages 211 and 215.

COLBERT COUNTY.

In the northern and eastern parts of this county the strata of the Subcarboniferous formation make the surface, but in the southern and western parts these older formations are covered by the mantle of sands, pebbles and clays of Tuscaloosa and Lafayette formations, the former of which carries the important clay deposits here as elsewhere. The best of these clays occur near the western border of the county, as well as in the adjacent parts of Mississippi.

The station Pegram, on the Memphis and Charleston Railroad, seems to be about the central point in this clay region. Some extensive works for the manufacture of fire brick and other kinds of brick have been established here under the name of the "Alabama Fire Brick Works." The clay is obtained from the southwest part of S. 27, the northeastern part of S. 3, and the northwestern part of S. 34, in T. 3, R. 15 W. The clay appears in several beds, as shown by the section below, which is taken from the notes of Dr. Little.

Section near Pegram, Colbert Co.

Pebbles of large size with sands................	30 feet
White clay, one-eighth of a mile from mill.......	3 feet
Small gravel............................	1 foot
White clay, sample No. 55, S..................	6 feet
Sand with large gravel overlying..............	16 feet
Yellow clay, sample No. 56, S..................	6 feet
White clay..............................	1 foot
Purple and black clay, sample No. 57, S..........	10 feet
Gray clay, sample No. 58.....................	5 feet

On land belonging to Mrs. C. Rhea, in the vicinity, Dr. Little gives the section as follows:

Yellow loam......	1 foot
Sandy clay (fire clay), sample No. 59..........	5 feet

Of these clays Dr. Ries has analyzed and tested Nos. 55, 56 and 57; No. 56 being classed by him among the china clays, while the other two are ranked as fire clays. The brick from this locality are used in Sheffield for lining the furnaces, and they are also used by the railroad.

In the Valley Regions Report, Part I, are given three analyses of clays collected from this region near the State line. These are as below:

Analyses of Clays from near Pegram.

	1.	2.	3.
Combined water......	8.250	6.827	7.085
Silica........	66.122	76.911	68.108
Alumina....	24.781	11.173	10.858
Ferric oxide....	trace	3.449	14.471
Total....	99.153	99.360	100.522

(1.) A light colored clay with small lumps of gritty matter.
(2.) A dark gray clay with black specks of organic matter.
(3.) A pinkish clay with white specks.

The light colored clay (1) above has been seen also on the south side of Little Mountain, near the bottom of the pebble hills, along the county line, a few miles northeast of Frankfort. It shows here in an irregularly stratified seam beneath the pebble bed. It is quite pure and white, and has occasionally found use as a whitewash, for which purpose it seems well adapted.*

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*Valley Regions, Part I, page 180.

LAUDERDALE COUNTY.

The Tuscaloosa formation, which carries the clay deposits, covers only the western half of Lauderdale, the Subcarboniferous rocks forming the surface over the eastern half. The clays are white, red and mottled, and generally quite plastic. Mr. McCalley gives some notes concerning them.

At the Tan-Yard Spring, in the N. E. ¼ of the N. W. ¼ of S. 24, T. 1, R. 14 W., there is the following section:

Section at Tan Yard Spring, Lauderdale Co.

Ferruginous crusts	1 foot
Clay, somewhat stained with iron, unctious and plastic when wet	5 feet

This clay has been analyzed by Dr. Pickel, of the University of Alabama, with the following results:

Analysis of Clay, Tan Yard Spring, Lauderdale Co.

Silica	59.65
Aumina	27.04
Ferric oxide	4.75

In the gullies, near the top of the divide between Brush and Bluff creeks, in the southwest of the northeast of S. 30, T. 1, R. 13 W., there are deposits of white unctuous clay from seven to eight feet thick.*

Dr. Little's notes supply some additional information about the clays of this county. Mr. Wm. J. Beckwith has a clay deposit four and one-half miles from Wright's postoffice, on Brush Creek. It is upon a high hill, and is five or six feet in thickness. The clay is of a light yellow color, and is firm, fine grained and smooth. It has been shipped north and sold for $12 a barrel, and can be delivered, barrel on the boat on the Tennessee river for $1 a barrel.

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*Valley Regions, Part I, page 105.

There is a red clay, suitable for paint, belonging the Sheffield Paint Company, near the county li six miles from Iuka, Miss. The bed is ten feet thi The white clay from Clingscale's Mill, Miss., m tioned above in the extract from Dr. Hilgard's repo comes from localities near the State line, west of L derdale county.

In many parts of this county there are beds white pulverulent silica, which have occcasiona found use. Thus at Florence the Mineral Paint a Tripoli Company make a paint by mixing clay a this fine silica together. At Waterloo, also, the sa white silica appears, as at Eastport, in Colbert cou ty. This material has been used in the manufactu of glass at Pittsburg, Pa.

TERTIARY AND POST TERTIARY FORMATION

The clays from these two formations have not y been specially investigated, the only representati herein contained being the flint clay from Chocta county. The material is spoken of under the head Fire Clays. There is a very great abundance of th clay in the counties of Choctaw, Clarke, Conecu etc., in the lower Claiborne or Buhrstone division the Tertiary. Over the greater part of the Coast Plain, in the river second bottom or Post Tertiar formations, there is the best of the yellow loam which are suitable for the making of the ordinar building brick. These loams correspond in age, a proximately, to the Plisocene clays of the norther states, which are so extensively used for the sam purposes. Besides these second bottom deposit there are lens of pure plastic clays to be found in many places interstratified with the prevailing sands of the formation. Many of these clays have been received and superficially tested, but it is the intention to extend the present investigation over that part of the state in the near future.

III

PRELIMINARY REPORT OF THE PHYSICAL AND CHEMICAL PROPERTIES OF THE CLAYS OF ALABAMA,

BY HEINRICH RIES, PH. D.

The tests which are described below were made in part on samples collected by the writer, and in part on samples collected by Prof. Smith. In the examination of the different lots of clay an endeavor has been made to perform such tests on the materials as would tend to give information of value to the practical clay worker.

This therefore includes the determination of the shrinkage of the clay in drying and burning, the degree of its plasticity, the color when burned at different temperatures, the temperature of incipient fusion, vitrification, and viscosity, and other minor points.

In some cases it is possible to state what the possible applications of a given clay are, but in many instances any one clay is susceptible of being mixed with two or three other clays and utilized in four or five different ways. The main point therefore, is to point out the properties of the deposits, so that the manufacturer may find out more readily whether the State contains materials of the nature desired by him, and in what portion of the State they are to be found.

It may be said in general that the results of the tests made indicate the occurrence of a great diversity of clays in the State, ranging from the more impure and easily fusible ones to the very refractory bauxites, which are unaffected by high temperatures.

These investigations relate chiefly to those deposits which have not yet been worked, with a view to aid the development of Alabama's clay resources; and consequently little is said with regard to the industry already established.

Where a number in parenthesis follows the name of the locality, it refers to the number in the writer's note book, unless succeeded by the letter S in which case the number is that on the label furnished by Dr. Smith.

The clays examined by me have been classified below as follows: China Clays; Fire Clays; Potters' Clays; Brick Clays; Miscellaneous Clays, and a few pages have been added on the utilization of clays, in the manufacture of Portland Cement.

CHINA CLAYS.

China clays might include those used in the manufacture of porcelain and white earthenware, and of these, two grades are recognized, i. e., kaolins, or china clay proper, and ball clays. The former possess little plasticity, a low percentage of fusible impurities, are generally highly refractory and burn to a pure white body. Very few kaolins can be put on the market in the condition in which they are mined, and most of them have to be washed in order to eliminate impurities which would tend either to discolor the clay or to render the texture far too coarse. The tensile strength of kaolins may vary from 5 to 15 lbs. or even reach 25 lbs., and the influence of this low strength is overcome by the addition of plastic ball clay. Iron is a very objectional impurity and should not exceed 1 per cent. indeed the less of it the better. Alkalies, if present as silicates, are not wholly undesirable for they serve as beneficial fluxes, but if contained in the clay as sulphates they may cause blisters, especially if the clay is heated too rapidly, and the same holds true of sulphate of lime or gypsum. Many washed kaolins approach very closely to the theoretical composition of kaolinite, while others even when washed may contain a high percentage of total silica due to the presence of much quartz and perhaps feldspar. If these two accessory minerals contain no iron they are harmless, especially if finely divided, and the rational analysis of clay is known. (See method of clay analysis.) The term kaolin is usually, and always should be restricted to white burning clays of residual origin. They are in most instances highly refractory, but they might also be of such composition as to bring about fusion at a low temperature, and at the same time burn white. It is the absence of plasticity in kaolins that necessitates the addition of ball clay, but some manufacturers use only the ball clay, mixed with quartz and feldspar for making porcelain. The last two minerals are indispensable ingredients of white-ware mixture, quartz being added for the purpose of preventing excessive shrinkage, and feldspar on account of its easy fusibility binding the mass together.

China clays should contain a low percentage of iron oxide, in fact the less the better, for in burning this compound tends to color the clay yellow or red. While the percentage of iron oxide should be under 1 per cent., nevertheless many of the best china clays used contain 1.25 to 1.35 per cent. of iron oxide. This production of a yellowish tint from such a quantity is prevented in two ways, first by adding a small amount of cobalt oxide to the white-ware mixture, or secondly by taking advantage of the fact that when the kiln, in which the ware is burned, is heated to a high temperature the fire tends to act reducing, thereby changing the iron coloration from yellow to bluish or bluish gray, and making it less noticeable.

Ball clays are used to mix with kaolin in the manufacture of porcelain and white-ware in order to give plasticity to the mass. They should be as free from fluxing impurities and mineral fragments as possible, and sometimes have to be washed. They generally burn nearly as white as kaolin. Ball clays should have a good tensile strength, not less than 60 lbs. to the square inch. They are often dark brown or even black from the presence of abundant organic matter, but this color disappears on heating. This organic matter exerts no other effect on the clay than to increase the plasticity and air-shrinkage.

The Alabama clays included under this heading are those which burn white or very nearly so at a moderately high temperature. Many of the specimens examined are quite siliceous, and consequently exhibit a low shrinkage in burning, while nearly all of them are of sedimentary origin. a few, such as those associated with the bauxite deposits, having an origin in common with them.

In respect to their geological relations the china clays here reported on come from three horizons, (1) the Cambrian and Silurian limestone, e. g. No. A. S. from Rock Run; No. 190 from near Gadsden; and No. 205 from near Kymulga, in Talladega Co. (2) the lower Sub-carboniferous cherty limestone; e. g. Nos. B. S; 128, and 214, from Willis' Valley, between Fort Payne and the Georgia state line. (3) the lower Cretaceous or Tuscaloosa formation, e. g. No. 38. S; No. 85; No. 37. S from Chalk Bluff and vicinity, Marion county: No. 37. S from Pearce's Mill, Marion county. and No. 56. S from Pegram in Colbert county.

Of the above, only the clays from Will's Valley have been regularly mined.

CHINA CLAY.

FROM DYKE'S ORE BANK, ROCK RUN, CHEROKEE CO.

(NO. A. S.)

A white, soft, gritty clay, which slakes easily in water.

The clay requires the addition of 30 per cent. of water to make a workable mass, which is quite lean. Bricklets made from this shrunk 4 per cent. in drying and an additional 12 per cent. in burning, making a total shrinkage of 16 per cent.

The tensile strength of the air dried briquettes is low, being only 9 lbs. per square inch on the average, with a maximum of 12 lbs. per square inch.

Incipient fusion occurs at 2000 degrees, F. The clay burns to a hard, marble like, dense body with a very faint bluish tinge at 2100 degrees F.

The analysis of the clay is as given below.

Analysis of China Clay, Rock Run, Cherokee Co. (No. A. S.)

Silica	60.50
Alumina	26.55
Water	7.20
Ferric oxide	.30
Lime	.90
Magnesia	.65
Alkalies	2.70
Moisture.	.70
	99.50
Total fluxes	4.55
Specific gravity	2.52

The rational composition is

Clay substance	70.30
Quartz	18.00
Feldspar	12.20
	100.50

This clay possesses an advantage in the density produced by moderate burning but its high shrinkage would have to be counteracted by the addition of more quartz.

CHINA CLAY.

FROM J. R. HUGHES, GADSDEN, ALA., (NO. 190.)

In the lump specimens this clay shows little evidence of stratification. It is mostly white in color, and on the average very fine grained 95 per cent of a lot of the sample sent passing through a 150 mesh sieve. There are scattered through it occasional lumps of the halloysite, so that the material would either have to be ground or washed before shipping it to market. The latter course would be more advisable as it at times shows yellow patches of color. When thrown into water the clay slakes moderately fast to flocculent particles. In washing it tends to stick on the sieve somewhat, and this might cause trouble in pottery manufacture unless ground quartz and feldspar were mixed with it in the proper proportions.

In working it up with water 37.50 per cent of water were required, and gave a mass of high plasticity.

The bricklets made from this had an air shrinking of 8 per cent.

In burning a noticeable property is the great density attained at a comparatively low temperature, but this is also accompanied by an additional though not great shrinkage. Thus, at about 2130 F. the total shrinkage was about 14 per cent. and the bricklet very dense; The color was white. At 2250 F. the shrinkage was 15 per cent. and the color white with a faint tinge of gray. At 2350 F. the shrinkage remained the same, and the color white with a faint cream tinge. Incipient fusion began at 2250 F.

The clay fused at cone 27 in the Deville furnace.

The clay has to be heated very slowly in burning in order to prevent cracking.

The tensile strength of the briquettes was tried in several different ways.

One lot was made from clay ground to pass through a 20 mesh sieve, and these showed a tensile strength of 137 lbs. per square inch, the maximum being 154 lbs, the variation in the different briquettes being 20 per cent. A second lot was ground to pass through a 60 mesh sieve, and here the average strength was 138 lbs. per square inch, the maximum being 143 lbs. and the variation 12 per cent.

A third lot was ground to pass through a 100 mesh sieve and here the average tensile strength was 132 lbs. per square inch with a maximum of 150 lbs. and a variation of 15 per cent.

The chemical analysis of this clay yielded:

Analysis of China Clay, J. R. Hughes. Gadsden. (No. 190.)

Silica	67.95%
Alumina	20.15
Ferric oxide	1.00
Lime	1.00
Magnesia	tr.
Alkalies	1.87
Ignition	8.00
	99.97
Total fluxes	2.00

There are many points of a desireable nature to be found in this material, viz., its high plasticity, its great density on burning, and its good tensile strength, all of which would combine to make it a ball clay of good quality. The color on burning is not quite as white as could be desired but no doubt washing would improve this.

CHINA CLAY.

TWO MILES N. OF KYMULGA, TALLADEGA CO. (NO. 205.)

A hard white clay, plainly stratified, due to the abundance of many white mica scales arranged parallel with the bedding. It is fine grained with a small amount of fine grit. It slakes very slowly breaking into scaly fragments.

When ground to pass through a 100 mesh sieve it required 18 per cent. of water to mix it up, and give it a mass which was only moderately plastic, owing to the high amount of mica which it contains.

The air shrinkage of the clay when thus mixed is 5 per cent.

When burned to about 2200° F, the color was pure white, and the total shrinkage 8½ per cent., but incipient fusion had not been reached.

At 2350° F, the color was white, and the total shrinkage 11 per cent.

In both cases the bricklets showed a tendency to crack in burning.

Incipient fusion occurred at cone 27 in the Deville furnace, but at cone 30 vitrification was not complete.

If used by itself it would probably not be safe to use the clay in its raw condition above 2250° without developing a yellowish tinge, although this migh not be noticeable when ball clay and quartz and feldspar were mixed.

The mica interfers with the tensile strength just as it did with the plasticity, so that the former did not exceed 15 lbs. to the square inch and varied between that and 12 lbs. per square inch.

The chemical analysis of the material is as follows:

Analysis of China Clay near Kymulga, Talladega Co. (*No.* 205.)

Silica	50.45
Alumina	35.20
Ferric oxide	.80
Lime	.60
Magnesia	.62
Alkalies	——
Ignition	12.40
	100.07
Total fluxes	2.02

The clay would no doubt work for the manufacture of white tile; or white earthenware, but could not be used for porcelain without being washed.

(No. B. S.)

CHINA CLAY,

EUREKA MINE, DEKALB CO.

It is whitish clay, with little or no grit, and of remarkable purity. In water it breaks up slowly to small grains.

It took 33 per cent. of water to temper it, and gave a lean mass, which shrunk 2 per cent. in drying, and an additional 6 per cent. in burning, giving a total shrinkage of 8 per cent. Air dried briquettes of the clay had an average tensile strength of 25 pounds per square inch, with a maximum of 27 pounds.

Incipient fusion occurs at 2300° F. vitrification at 2500° F., and viscosity above 2700° F.

The clay burns to a very white, smooth body.

An analysis of the clay gave the following results:

Analysis of China Clay, Eureka Mines, DeKalb Co. (No. B 8.)

Silica	47.00
Alumina	38.75
Water	12.94
Clay base	98.69
Ferric oxide	.95
Lime	.70
Magnesia	tr
Alkalies	tr
	100.38
Total fluxes	1.65
Specific gravity	2.34

This clay approaches closely to kaolinite in its composition.

(No. 128.)

CHINA CLAY,

H. H. GRIFFIN, EUREKA MINE.

This is a white clay, which represents the best quality obtained in the mines of H. H. Griffin, four miles northeast of Valley Head.

It is a very gritty, lean clay, which took 38.50 per cent. of water to work it up.

The air shrinkage was 3½ per cent., and at 2250° F. it had only shrunk 6 per cent., and barely showed signs of incipient fusion. Vitrification takes place at 2800° F. The analysis of a clay from this locality, from what is known as the Eureka Mine, and made by A. T. Brainard, was kindly furnished to the writer by Mr. Griffin. It is as follows:

Analysis of China Clay, Eureka Mines, DeKalb Co.

Silica	53.7300
Alumina	34.5390
Ferrous oxide	.8530
Lime	.4144
Magnesia	.3420
Alkalies	tr
Sulphuric acid	.2018
Phosphoric acid	.0522
Ignition	12.28
	102.4124
Total fluxes	1.609

The following analysis of sample collected by writer from the mines in 1897, gave the following:

Analysis of China Clay, Eureka Mines, DeKalb Co. (*No.* 128.)

Silica	82.11
Alumina	11.41
Ferric oxide	1.40
Lime	tr
Magnesia	.661
Alkalies	1.80
Ignition	4.001
	4.001
	101.882
Total fluxes	3.86

The rational analysis gave.

Clay substance	20.20
Quartz	69.20
Feldspar	10.40
	99.80

The feldspar percentage influences the fusibility of this clay, and the difference in the two quantitative analyses is due to the latter having been made on an unwashed sample.

(No. 214.)

CHINA CLAY,

FROM F. Y. ANDERSON, NEAR FORT PAYNE, DEKALB CO.

This clay is rather sandy in its nature, unless ground extremely fine, the granular character being due partly to the halloysite which it contains.

It slakes very slowly and incompletely, and took in its air dried condition 30 per cent. of water to work it up.

The air shrinkage of the bricklets was 7 per cent. At cone 27 in the Deville furance, it was white and showed traces of incipient fusion. At about 2350° F., it burned white without a trace of yellowish color, and with a total shrinkage of 11 per cent.

It is evident that this material could be used in the manufacture of white ware. It would, however, take much grinding to develop its plasticity fully.

The tensile strength was from 60 to 65 pounds per square inch when the material was ground to 60 mesh, and the briquettes are very constant in strength. With finer grinding the tensile strength would very probably increase.

The chemical analysis yielded:

Analysis of China Clay, F. Y. Anderson, DeKalb Co. (No. 214.)

Silica	53.50
Alumina	34.45
Ferric oxide	.21
Lime	.30
Magnesia	trace
Alkalies	.21
Ignition	13.20
	101.87
Total fluxes	.72

(No. 38 S.)

CHINA CLAY.

J. J. MITCHELLS, CHALK BLUFF, MARION CO.

Pure white, fine grained clay, brittle when dry, and with conchoidal fracture. It slakes easily in water, all of it passing through a 60 mesh sieve and most of it through a 100 mesh one.

The clay ground to pass through a 30 mesh sieve, and mixed with 24 per cent. of water, gave a lean mass whose air shrinkage was 4 per cent. and an additional shrinkage of 3 per cent. took place in burning, giving a total of 7 per cent.

Air dried briquettes of the clay gave the usual low tensile strength of kaolin, the average being 15 pounds per square inch, with a maximum of 17 pounds per square inch.

Incipient fusion occurs at 2300° F., vitrification at 2600° F., annd viscosity at 2700° F.

The clay burns to a clear white body. Its composition is as follows: (No. 1 being by H. Ries and No. 2 by W. B. Phillips. No. 3 is the composition of pure kaolin given for comparison.)

Analyses of China Clay, Chalk Bluff, Marion Co.

	1	2	3
Silica	47.25	47.20	46.30
Alumina	36.50	37.76	39.80
Water	13.35	14.24	13.90
Ferric oxide	2.56	tr	
Lime	tr	tr	
Magnesia	tr	tr	
Moisture	.50	tr	
	100.16	99.20	100.00
Total fluxes (!)			2.56
Specific gravity			2.44

(No. 85.)

CHINA CLAY.

CHALK BLUFF, MARION CO.

This clay which occurs on the property of Mrs. Nelson is a smooth, white, fine grained clay with a conchoidal fracture. It slakes easily into angular grains. It is very lean, and requires 33 per cent. of water to mix it up. The tensile strength is also very low, being only 15 pounds per square inch. The air shrinkage is 4 per cent.

At 2200° Fahr. the total shrinkage was 10 per cent. At. 2350°, it was 15 per cent., and the bricklet incipiently fused, with a yellowish white color.

At 2500°, the total shrinkage was 18 per cent. The color was yellow. Vitrificaton occurred at 2700° F.

In the Deville furnace, at cone 27, the clay was nearly viscous.

No analysis was made of this clay.

(No. 37 S.)

CHINA CLAY.

BRIGGS FREDERICK, NEAR CHALK BLUFF, MARION CO.

This was a fine grained clay, 90 per cent. of it passing through a 60 mesh sieve. The clay took 25 per cent. of water to be worked up, and even then was lean and granular, fine grinding being necessary to develop proper plasticity.

The air shrinkage was 2½ per cent. and the fire shrinkage was the same, giving a total shrinkage of 5 per cent. in the case of a sample ground to pass through a 30 mesh sieve.

The air dried briquettes showed an average tensile strength of 14 pounds per square inch, and a maximum of 16 pounds.

Incipient fusion occurs at 2300° F., vitrification at 2500° F., and viscosity above 2700° F. The clay burns to a white but somewhat porous body.

Its composition is as follows:

Analysis of China Clay, Briggs Frederick, Marion Co. (No. 37, S.)

Silica	65.49
Alumina	24.84
Water	7.50
Ferric oxide	tr.
Lime	1.26
Magnesia	tr.
Alkalies	tr.
Moisture	.30
	99.37
Total fluxes	1.26
Specific gravity	1.76

This clay is very low in iron, and the small percentage of lime is no detriment.

(No. 36 S.)

CHINA CLAY.

PEARCE'S MILL, MARION CO.

A hard, porous, coarse grained, gritty clay, which in water breaks up slowly into angular fragments, each of which in turn keeps splitting.

Twenty-five per cent. of water was required to work it up, but it is very lean. The air shrinkage was 3 per cent. and an additional 12 per cent. in burning, making a total of 15 per cent.

The tensile strength of air dried briquettes varied on the average 12-14 pounds per square inch with a maximum of 20 pounds per square inch.

Incipient fusion occurred at 2300° F., vitrification at 2500° F., and viscosity at over 2700° F.

The clay burns at 2300° F. to a very white body.

The analysis of it yielded.

Analysis of China Clay, Pearce's Mill, Marion Co. (No. 36, S.)

Silica (combined)	38.60	
Alumina	32.50	
Water	11.05	
Clay base		82.15
Silica (free)	17.68	
Ferric oxide	.20	
Lime	tr.	
Magnesia	tr.	
Alkalies	tr.	
Moisture	.20	
	100.03	
Total fluxes	.20	
Specific gravity	2.83	

With washing, this clay would probably be well adapted to the manufacture of the highest grades of pottery. It contains less fusible impurities than most of the kaolins used in this country, and the probabilities are that if the deposit were constant in its character it might not require washing.

(No. 56 S.)

CHINA CLAY.

PEGRAM, COLBERT CO.

A fine grained, whitish, homogeneous but not very dense clay with a smooth fracture.

In water it slakes slowly to grains under a sixtieth of an inch (1-60 in.)

Thirty per cent. of water was required to make a workable mass, which to the feel was quite lean. The air shrinkage of bricklets made from it was 7 per cent., and 4 per cent. in burning, making a total of 11 per cent.

The tensile serength of the air dried briquette was quite low, being 40 pounds per square inch on the average, with a maximum of 53 pounds per square inch.

Incipient fusion occurs at 2200° F., vitrification at 2400° F., and viscosity at 2600° F.

The clay burns to a white body which is hard and dense, the following is the analysis of the clay.

Analysis of China Clay, Pegram, Colbert Co. (*No.* 56, S.)

Total Silica	64.90
Alumina	25.25
Water	8.00
Moisture	.90
Ferric oxide	trace
Lime	trace
Magnesia	trace
	99.05
Free silica	34.40
Specific gravity	2.85

The material is to be looked upon as a white-ware clay of good grade, from which the sand could be removed by washing if necessary. There are practically no published analysis with which this agrees very closely, but a comparion is not necessary as the purity of the material is self evident.

FIRE CLAYS

The term fire-clay is applied to those clays which will resist a high temperature without fusing.

Fire clays are of two kinds, flint clays and plastic clays.

The flint clays generally approach kaolinite in composition, but have no plasticity, or at the most a very slight degree of it. They are generally of a highly refractory nature, their fusing point being commonly above 2700° F. and their shrinkage in drying and burning is extremely low. They therefore make an excellent grog to add to the more plastic clays for the purpose of reducing their shrinkage. Flint clays have thus far not been found in Alabama, except in Conecuh, Choctaw, Washington, Clarke and Monroe counties.

Plastic fire clays are widely distributed and are especially abundant in the Coal Measures of many states, but they may also ocsur in the Cretaceous and Tertiary formations. Those of the Carboniferous are often of a shaly nature and to be ground before their plasticity can be brought forth.

The requisite qualities of a fire clay vary somewhat according to the use to which it is to be put, and it is still a disputed point, just what temperature the fusion point of a clay should exceed in order to be classed as a refractory one. As it now stands, many American clays are unfortunately and erroneously classed as fire clays which can not withstand a temerature of more than 2300° or 2400° F. Many of the New Jersey fire clays require a temperature of from 2500° to 2600° F. to burn them.* The fire clays of Missouri fuse at from 2400° to above 2700°.

No arbitrary line can be drawn between refractory and semi-refractory clays, but if such a division were made it would seem advisable not to call any clay refractory which is affected by a temperature of less than 2700° F. Many of the Alabama fire clays conform to this definition.

While it is desirable that fire clays should posses good plasticity and low shrinkage, the main point is their refractoriness. It may be said in general that the fusible impurities of a fire clay should not exceed 3½ or 4 per cent., but these limits may be extended somewhat in either direction depending upon the nature of the flux and whether the clay is fine or coarse grained.

The shrinkage of a fire clay in burning may often be counteracted by the addition of grog, i. e. sand, ground fire brick, or similar substances.Fire clays which are too fat and plastic are likely to crack in burning, but at the same time they give a dense body. It is desirable that any burned clay or grog which is mixed with the raw material should have previously been burned as dense as possible. Fine grains of powdered grog permits the brick to shrink more in burning than the course and bricks with the latter generally stand changes of temperature better. Next to burned clay, quartz is perhaps the most important grog, and flint clay serves a similar purpose.

If a fire brick made only of clay and clay grogs still shrinks when placed in the furnace, sharp quartz grains should be added, as they have a tendency to expand on repeated heating. Fine grained quartz sand should in no case be added if the brick is to be exposed to high temperatures, for in such cases it tends to flux the clay in burning, furthermore the addition of coarse quartz must also be within limits for if in too large quantity the quartz grains loosen the brick by their expansion. A good fire brick is sometimes made by mixing a non-plastic refractory clay with a very plastic dense burning, semi-refractory one.

No fixed rules can be laid down to govern the selection and valuation of a fire clay for the reason that the use to which it is to be put determines its qualities to a large extent. All fire clays should resist a high temperature. Some are used in situations requiring resistance to heat and these must be coarse grained. Others when burned into bricks must resist corrosion and consequently should burn to a dense product, as in the case of glass pot clays.

Fire bricks.—These should show a resistance to high temperatures, and also the fluxing action of ashes from the fuel, which contain carbonates, sulphates, and phosphates of the alkalies and alkaline earths. In addition they should withstand the corrosive action of fused metallic slags, alkalies, and glasses.

The density of the fire brick is often of great importance especially where it is to resist the corrosive action of molten material. The fat plastic clays are those which usually burn to the most dense body, but in doing so they frequently crack to such an extent that grog has to be added to them.

Porous, coarse grained bricks on the other hand stand heat better.

The fire-clays below reported on come from four geological horizons, viz., (1) The Cambrian and Silurian limestone formations of the Coosa Valley region; No. 191 from Peaceburg, Calhoun county; No. 127 Stevens, from Oxanna, Calhoun Co.; the refractory clays of Rock Run, Cherokee Co.; and the bauxites from the same locality. (2) The cherty limestones of the lower Subcarboniferous formation of Wills' Valley; No. 117 and 116 from the Montague mines, and No. 119 from near Valley Head in DeKalb county. (3) The Tuscaloosa formation of the Lower Cretaceous, No. 112 from Bibbville, and No. 111 from Woodstock in Bibb county; No. B from near Hull's Station, and No. 118 from near Tuscaloosa in Tuscaloosa county; Nos. 1 and 2 from Pearce's Mills in Marion county and No. 57 S. from Pegram in Colbert county. (4) The lower Tertiary formation, No. C S from Choctaw county. Of these only the clays from Bibbville and Woodstock have been regularly mined.

(No. 191.)

FIRE CLAY.

FROM PEACEBURG, NEAR ANNISTON.

A grayish white clay of very fine grain, and containing a noticeable amount of very fine mica scales. In water it slakes moderately fast.

Twenty-five per cent. of water was required to work it up, and the resulting mass was rather lean, and had a somewhat flaky structure, which interferred with the development of the plasticity.

Bricklets made from the mixture had air shrinkage of 5 per cent.

When burned to about 2100° F. the total shrinkage amounted to 10 per cent, the clay was white with a faint tinge of yellow and the brick was still very porous. At about 2250° F. incipient fusion has barely been reached, w'th a total shrinkage of 13 per cent., the color being white tinged to a noticeable extent with yellow. At about 2300° F. the bricklet burned cream color, was incipiently fused, and the total shrinkage amounted to 15 per cent.

In the Deville furnace the clay vitrified at cone 30, but did not lose its shape.

Owing to the leanness the tensile strength was very low, and ranged from 20 to 25 pounds per square inch.

The chemical analysis of the clay gave:

Analysis of fire clay, Peaceburg. Calhoun Co. (No. 131.)

Silica	51.90
Alumina	35.00
Ferric oxide	.99
Lime	.23
Magnesia	.10
Alkalies	.55
Ignition	11.30
	99.87
Total fluxes	1.87

The low plasticity of this clay would probably interfere with its being used alone, but owing to its refractory nature and the light color developed in burning it could no doubt find use as an ingredient of other clay mixtures.

(No. 127 of Mr. Stevens.)

FIRE CLAY.

FROM OXANNA, CALHOUN COUNTY.

This is a coarse and sandy clay, which mixes up to a lean mass with only 16 per cent. of water. The tensile strength is very low, being on the average of 9 to 10 pounds per square inch, and the air shrinkage is 2 per cent.

The following is the behavior of the clay at successively higher temperatures.

At 2200° F. the color was grey white.

At 2250° F. shrinkage 3 per cent., color buff.

At 2300° F. shrinkage and color same.

At 2400° F. shrinkage 3 per cent., color buff, showing specks of ferric oxide.

At 2500° F. the shrinkage was only 2 per cent., having undergone a slight swelling owing to the very high quartz percentage. Incipient fusion had not occurred up to this point. The following is the analysis of this clay.

Analysis of Fire Clay, Oxanna, Calhoun Co. (No. 127, Stevens).

Silica	84.21
Alumina	9.75
Ferric oxide	.69
Lime	.70
Magnesia	.14
Ignition	4.10
	99.59
Total fluxes	1.53

REFRACTORY CLAYS

OF ROCK RUN, CHEROKEE COUNTY.

Associated with the bauxites at Rock Run are a number of clays, most of them of fine grained texture, but some showing small quantities of grit, and which vary in color from pure white to mottled ones, which at times contain an appreciable percentage of sand. Samples of these clays from six different locations have been tested, they come from what are known as the Dykes old Iron Ore Mine and the Dykes Bauxite Mine, on the property of the Rock Run Iron Mining Co. in Cherokee county.

No. 1. is on the north side of the iron mine reservation at the extreme western end; No. 2 and 3 are from the same side of the pit, but at points 125 and 200 feet farther east respectively; No. 4 is from the western end of the Bauxite pit and on the north side of the entrance to it; No. 5 is on the north side of the same pit and No. 6 at the eastern end of it.

Nos. 1, 2, 3, each show a face 15 to 20 feet in height, and are of probably greater thickness. No. 4 is looked upon as a very low grade of bauxite.

The following tests mere made upon these samples:

No. 1. This is a fine grained white clay, with a splintery fracture, showing iron stains along the joint cracks and other planes or fracture, but none in the interior of the mass. It slakes quickly but not completely into angular fragments. In mixing it up, 32 per cent. of water was required and the resulting mass was lean and granular. It had been previously passed through a 30 mesh sieve, and it ground to a finer mesh would, no doubt, be more plastic. The lean granular character gives it a very low tensile strength amounting to not over 6 pounds.

The air shrinkage of the clay was 4 per cent. at about 2200½ F., the total shrinkage was 9 per cent; and at about 2300°, 18 pr cent., at about 2500°, the total shrinkage was 21.50 per cent, and the color of the burned bricklet was still white.

When tested in the Deville furnace at cone 30 the form of the clay still remained sharp, and it was white in color, but showed signs of incipient fusion.

The compositicn of the clay is as follows:

Analysis of Fire Clay, Rock Run, Cherokee Co. (No. 1.)

Silica	47.60
Alumina	36.70
Ferric oxide	1.10
Lime	1.30
Magnesia	trace
Alkalies	trace
Ignition	14.20
	100.90
Total fluxes	2.40

These tests indicate that the clay is quite refractory, and its burning to a white color would permit its being used for products having a white body. The high shrinkage is somewhat against it, but this could be counteracted to a large extent by the addition of quartz and it would also be necessary to mix it with some plastic clay, if it was to be molded when wet.

No. 2. This is similar to No. 1 in its color and texture. It is however much more plastic than the other although it only required 31.25 per cent. of water to mix it, the tensile strength however is very low, and in this case bears no relation to the plasticity, the air shrinkage of the clay is 3 per cent; at about 2200° F., the total shrinkage was 10 per cent. and the bricklet was still absorbent although incipient fusion had just begun, while the color was yellowish white; at about 2250° F., the total shrinkage was 14 per cent., the bricklets had an absorption of about 5.7 per cent. and the color still a yellowish white. At about 2300° F. the total shrinkage was 16 per cent., the absorption only 2 per cent. while its color was a very faint yellowish gray; the total shrinkage was 17 per cent. at 2400° F., and the bricklet which appeared nearly vitrified, was gray in color.

In the Deville furnace at cone 30, the form of the clay was still perfectly sharp, and while it was thoroughly vitrified it showed no evidence of becoming viscous.

The rational composition of the clay was:

Clay substance	94.54
Quartz	5.80
Ferric oxide	.26

No. 3. This is likewise a white clay but one containing much fine grit, not very porous, and slaking quickly to a powder. It is also a very plastic clay, and took 36.50 per cent. of water to work up, but the tensile strength again is very low, being not over 5 pounds. The air shrinkage was 3 per cent.; at about

2200° F., the total shrinkage was 12 per cent., and the bricklet white, with an absorption of 7.20 per cent. At about 2250° F. the total shrinkage was 13 per cent. and the bricklet, which had an absorption of 6.3 per cent. was white with a very faint tinge of yellow. At about 2300° F., the total shrinkage amounts to 15.5 per cent., the color of the bricklet white with a mere shade of gray, and the absorption of it had decreased to 1.3 per cent. The total shrinkage at about 2500° F. was 17.5 per cent. and vitrification had occurred, the bricklet being whitish in color.

In the Deville furnace at cone 30, the form of the clay pyramid was still erect, and while the clay was thoroughly vitrified the angles were still sharp and color whitish. The composition is:

Analysis of Fire Clay, Rock Run, Cherokee Co. (No. 3).

Silica	72.20
Alumina	22.04
Ferric oxide	.16
Lime	.50
Magnesia	.40
Alkalies	.60
Ignition	5.80
	101.70
Sand	34.52
Total fluxes	1.66

No. 4. This clay as has already been stated is a low grade bauxite, it is white in color with a slight yellowish tinge and portions of it show a pisolitic structure. It slakes quickly. 31.35 per cent. of water were required to work it up and even then the mud was extremely granular and very lean, and the air dried briquetts had a tensile strength of only 5 pounds. The air shrinkage was 5 per cent. At 2250° F. the total shrinkage was 14 per cent., the bricklets

very porous, of a white color with a mere tinge of yellow. At 2400° F. the total shrinkage was 15 per cent.

In the Deville furnace at cone 27, the clay still remained entirely unaffected, but the color was grayish, and the total shrinkage up to this point amounted to 26 per cent.

The composition of the clay is:

Analysis of Fire Clay, Rock Run, Cherokee Co., No. 4.

Silica	17.70
Alumina	59.46
Ferric oxide	.36
Ignition	22.06
	99.58
Total fluxes	.36

No. 5. This is a soft whitish, easy slaking clay, but a very porous one which absorbs 40 per cent. of water in working it up, and even then gave a very lean mass, whose tensile strength, when made into briquettes and air dried, was only 5 pounds per square inch. The air shrinkage is 4 per cent, and at about 2250° F. the total shrinkage was 17 per cent., but the bricklets, whose color was yellow, were still very porous and could be scratched by a knife without much difficulty; at 2400° F., the shrinkage showed a total of 22 per cent. and incipient fusion began; at 2500° F., the total shrinkage was 23 per cent., the brick was still porous and faintly yellowish white.

In the Deville furnace at cone 30, the clay had burned dense, was incipiently fused, but otherwise unaffected, its color was a grayish white and the total shrinkage amounted to 34 per cent., which is really not surprising when we consider the high amount of combined water that the clay shows, for it is evidently a low grade bauxite like the preceding one.

The composition is:

Analysis of Fire Clay, Rock Run, Cherokee Co., No. 5.

Silica	31.20
Alumina	44.28
Ferric oxide	1.45
Lime	1.00
Magnesia	.20
Ignition	22.60
	100.73
Total fluxes	2.65

This clay is evidently a mixture of clay and bauxite, as can be seen from the high shrinkage and large percentage of combined water.

No. 6. The color of this clay is yellow, and it is fine grained but not hard, and shows numerous slickenside surfaces. In slaking it breaks up easily but slakes completely to powder only after long immersion in water. The clay is very lean, and requires as much water as the preceding to mix it up; the tensile strength is also very low being under 5 pounds. The air shrinkage is 2 per cent., the total shrinkage at 2200° F. is 8 per cent.; at 2250° F. it is 12 per cent.; at 2400° F. it is 13 per cent; at 3500° F. it is 15 per cent.; at 2600° F. it is 20 per cent., and the bricklet was still very absorbent.

In the Deville furnace at cone 27, the clay had burned dense, but still preserved its form with sharp edges and showed a total shrinkage up to this point of 35 per cent.

The composition of the clay is as follows:

Analysis of Fire Clay, Rock Run, Cherokee Co., No. 6.

Silica	34.60
Alumina	45.80
Ferric oxide	.52
Ignition	20.00
	100.92
Total fluxes	.52

REFACTORY BAUXITES.

ROCK RUN, CHEROKEE COUNTY.

In addition to these bauxitic clays, six samples of bauxite were also tested chiefly to determine their refractoriness and their shrinkage in burning, the method adopted with most of them being to grind up the specimen, so that it would pass through either a 20 or a 30 mesh sieve, the particles which did not pass through being also retained. Several mixtures of the coarse and fine material were made. The mass produced in every instance by mixing it with water was extremely low in its plasticity, and lacked greatly in tensile strength, the latter in every instance being not more than 2 or 3 pounds per square inch.

In many cases, the bauxite showed so little tenacity and was so little affected by the heat that bricks which had been burned at a temperature of 2600° F. were easily rubbed apart with the fingers. Another point to be noticed is the enormous shrinkage which all of the specimens exhibited, the air shrinkage, however, being very low.

No. 1. This was powdered and passed through a 30-mesh sieve, and on working up gave a very lean mass, which required 24 per cent. of water. The air shrinkage was 3 per cent. and at 2400° F. the total shrinkage was 11 per cent, while the bricklet was very porous and white. At 2500° F. the bricklet had not shrunk any more but the color had become reddish.

In the Deville furnace at cone 30, the bauxite was totally unaffected although it had become somewhat dense, and showed a shrinkage of 23 per cent. The composition was:

Analysis of Bauxite, Rock Run, Cherokee Co., No. 1.

Silica	8.80
Alumina	61.64
Ferric oxide	1.10
Lime	trace
Magnesia	trace
Ignition	29.97
	100.51

No. 2. Two mixtures were made of this, viz: *a.* which was 50 per cent. of grains between 15 and 20-mesh, and 50 per cent. smaller than 20-mesh. The bricklet made from this showed a total shrinkage of 12 per cent. at 2400° F., while at 2600° F., the shrinkage was 14 per cent. and the bricklet was so friable that it could be easily rubbed apart.

b. The bauxite was ground and passed through a 30-mesh sieve. In this condition it took 25 per cent. of water to mix it up, and made a very lean paste. The shrinkage of the bricklets made from this was about 10 per cent at 2250° F., they were very porous, soft, and of a slight yellowish tint; at about 2400° F. the total shrinkage was 15 per cent. and at 2600° F. amounted to 17 per cent., but the bricklet was still scratched by a knife without much difficulty. In the Deville furnace the bauxite was still uneffected at cone 30, but showed a total shrinkage of 27 per cent.

Its composition is:

Analysis of Bauxite, Rock Run, Cherokee Co., No. 2.

Silica	18.30
Alumina	54.39
Ferric oxide	1.36
Ignition	27.60
	101.65

72. (No. 3.) Ground to pass through a 20-mesh sieve, it gave a very lean mass on the additcn of 25 per cent. of water.

The air shrinkage was 2 per cent.

At 2400° F. the brick was very loose and crumbly.

At 2500° F. shrinkage 11 per cent.

At 2600° F. shrinkage 18 per cent.

At 3150° F. shrinkage 22 per cent. Totally unaffected.

Analysis of Bauxite, Rock Run, Cherokee Co., No. 3.

Silica	3.30
Alumina	69.06
Ferric oxide	.20
Lime	....
Water	28.10
	100.66

48. (No. 4.) Three mixtures were made up as follows:

a. 33 per cent. smaller than 20-mesh.
67 per cent. 10-20 mesh.

b. Under 30 mesh.

c. Under 20-mesh.

All three gave lean mixtures.

a. Took 23 per cent. water to work it up.

b. Took 20 per cent. water to work it up.

c. Took 24 per cent. water to work it up.

The air shrinkage was *b.* 2 per cent., *c.* 1 per cent.

At 2400° F. *b* showed 10 per cent. shrinkage and the particles barely colored.

At 2500° F. *b* had shrunk 11 per cent. and held; *c* 13 per cent. but was very loose.

At 2600° F. *b.* and *c.* had both shrunk 13 per cent. but could still be scratched by the knife.

At 3000° F. the bauxite was unaffected, and showed a total shrinkage of 17 per cent.

Analysis of Bauxite, Rock Run, Cherokee Co., No. 4.

Silica	3.30
Alumina	66.70
Ferric oxide	.10
Water	31.30
	101.40

49. (No. 5.) Mixtures made were:

a. 35 per cent. 10-20 mesh and 65 per cent. under 20 mesh. Required 18 per cent. of water to work up.

b. under 30-mesh. Required 20 per cent. of water.

c. under 20-mesh. Required 25 per cent. of water.

The air shrinkage of all was 1 to 2 per cent.

At 2550° F. the shrinkage was 20 per cent.

The bauxite when heated to cone 30 in the Deville furnace, preserved its form and sharp edges, and showed the faintest trace of incipient fusion. It is therefore highly refractory.

Analysis of Bauxite, Rock Run, Cherokee Co., No. 5.

Silica	.28
Alumina	68.14
Ferric oxide	trace
Water	32.60
	101.02

73. (No. 6.) A whitish, claylike bauxite. This took 46 per cent. of water to work it up and gave a fairly plastic mass, but had very little tensile strength.

At 2400° F. the shrinkage was 10 per cent., bricklet still soft enough to be scratched by the nail.

At 2550° F. shrinkage 27 per cent.

At 2600° F. shrinkage 30 per cent., brick resisted scratching by a knife.

At 3100° F. bauxite dense, gray in color, but form perfectly sharp.

Analysis of Bauxite, Rock Run, Cherokee Co., No. 6.

Silica	9.50
Alumina	61.14
Ferric oxide	trace
Lime	trace
Magnesia	trace
Water	31.20
	101.84

The foregoing tests of these bauxites show a high refractoriness, but also a very high shrinkage which increases apparently with the fineness of grain. It is difficult to draw conclusions from six specimens, however, just what the relations of silica, alumina, water and size of grain are which influence the shrinkage.

All of these bauxities would, of course, have to be first calcined if used for refractory purposes; but they could then be mixed with a small amount of plastic clay to serve as binder and would then make a very refractory article. In my report I shall discuss this point.

(No. 117)

FIRE CLAY.

NEAR VALLEY HEAD, DEKALB COUNTY.

The clay mines of the Montagues are situated about two mile up the railroad from Valley Head, and a few hundred feet to the west of the track. Several grades of clay are obtained from the mines, but they are not restricted in any case to certain layers. The following sample tested is what is known at the mines as the first grade, and its refractory character is not by any means low.

The material is a white sandy clay, rather coarse grained and containing occasional reddish or pinkish stains. There is no mica to be seen in it. It is hard but very porous, and practically does not slake when immersed in water for a long period.

When mixed with 35 per cent. of water it gave a gritty but lean mass, which had an air shrinkage of 4 per cent. In this case it had been ground to pass through a 60-mesh sieve. When ground to pass through a 100 mesh sieve it absorbed the same quantity of water but the plasticity was slightly increased, while the air shrinkage remained about the same.

At 2100° F. the clay burns white; at 2300° F. it is white with a slight tinge of yellow, and at 2350° F. it is the same with the total shrinkage amounting to only 4 per cent. Incipient fusion occurs at 2400° F. and at cone 27 in the Deville furnace the clay vitrified.

The tensile strength is very low, not over 5 or 6 pounds per square inch.

The chemical analysis yielded:

Analysis of Fire Clay, near Valley Head, DeKalb Co. (*No.* 117).

Silica	82.04
Alumina	12.17
Ferric oxide	trace
Lime	trace
Magnesia	.327
Alkalies	.60
Ignition	4.325
	99.462

Total fluxes	9 27
Specific gravity	2.38

The rational composition is:

Clay substance	31.10
Quarts	64.80
Feldspar	3.90
	99.90.

(No. 116.)

FIRE CLAY.

NEAR VALLEY HEAD, DEKALB COUNTY.

Occurring in the same quarry is what is known as the second grade of fireclay. This is a fine grained yellowish gray clay containing much fine grit. It slakes quite quickly when thrown in water, and when worked up with 39 per cent. of water gave quite a plastic mass. The air shrinkage of the bricklets amounted to 8 per cent. which is greater than that of the first grade, which was also less plastic. The tensile strength seems to have increased with the plasticity for it amounted to 20 pounds per square inch. When burned to 2350° F. the total shrinkage was 17 per cent. and incipient fusion took place, while vitrification occurred at 2700° F. and at cone 27 in the Deville furnace the clay fused but did not run. It will be thus seen that it is less refractory than the so called first grade, which only vitrified at this latter temperature. Both are to be classed as fireclays however. Up to incipient fusion, the clay remains white, but above that it begins to show a yellowish tint due to the presence of iron oxide in the clay.

The chemical composition of the clay is:

Analysis of Fire Clay, near Valley Head, DeKalb Co. (*No.* 116).

Silica	79.80
Alumina	11.75
Ferric oxide	1.75
Lime	.75
Magnesia	trace
Alkalies	1.50
Water	4.11
	99.16
Total fluxes	3.50
Specific gravity	2.37

The rational analysis of the clay gave:

Clay substance	31.20
Quarts	58.00
Feldspar	10.80
	100.00

(No. 119).

FIRE CLAY,

FROM NEAR FORT PAYNE, DEKALB COUNTY.

Major F. Y. Anderson has made several openings to the west of the Alabama Great Southern Railroad at several points between Valley Head and Fort Payne.

The clay found in these pits is in appearance not unlike that which is found in the mines of Montague and Griffin to the northward. The different grades are recognized.

The second grade, as it is called, No. 119, is a somewhat soft, gritty, lean clay, of a yellowish color, due to the numerous stains of iron oxide, and when thrown into the water slakes slowly to a powder.

Forty per cent. of water gave a lean mass, and the air shrinkage of the bricklet made from this was 8 per cent. Incipient fusion occurs at 2300° F., the total shrinkage at this point being 14 per cent., and the bricklet is yellowish white. When heated to cone 27 in the Deville furnace the clay showed vitrification. While it is fairly refractory in its nature, at the same time, owing to the yellowish tint developed in burning, it would not, in its natural condition, do for the manufacture of white ware. It is possible, however, that washing might eliminate some of the undesirable impurities.

The chemical composition is as follows:

Analysis of Fire Clay, near Fort Payne, DeKalb Co. (*No.* 119).

Silica	66.25
Alumina	22.90
Ferric oxide	1.60
Lime	trace
Magnesia	trace
Alkalies	.75
Ignition	9.05
	100.55
Total fluxes	2.35
Specific gravity	2.28

The rational analysis yielded:

Clay substance	40.70
Quartz	47.90
Feldspar	11.20
	99.80

(No. 112).

FIRE CLAY,

FROM BIBBVILLE, BIBB COUNTY.

This is one of the clays used by the fire brick works at Bessemer, near Birmingham. For use it is mixed with several other clays.

The material itself, however, is a very sandy clay, with much coarse grit and appreciable quantity of mica. It is also abundantly stained with limonite in places. When thrown into water it slakes fairly fast and falls to powder. It is quite a plastic clay, but in working it up into a plastic mass it took only 22.6 per cent. of water.

The air shrinkage amounts to 6½ per cent. At about 2200° F. the clay burns creamy white, and shows a total linear shrinkage of 9 per cent. While at about 2300° F. incipient fusion is reached, with the shrinkage the same, and the color buff. Vitrification was not attained until the clay was heated to cone 27 in the Devilie furnace, and even at this temperature the clay cone remained still perfectly sharp.

The tensile strength is moderate, ranging from 75 to 110 pounds per square inch, with an average of 102 pounds per square inch.

The analysis of this fire clay is:

Analysis of Fire Clay, Bibbville, Bibb Co. (No. 112).

Silica	74.25
Alumina	17.25
Ferric oxide	1.19
Lime	.40
Magnesia	tr.
Alkalies	.52
Ignition	6.30
	99.39
Total fluxes	2.11
Specific gravity	2.44

(No. 111).

FIRE CLAY,

ELGIN PROPERTY, NEAR WOODSTOCK, BIBB COUNTY.

A sandy, micaceous clay, of yellowish color, which breaks up slowly, but completely, when immersed in water. This needed 23 per cent. of water to work it up, and gave a moderately plastic mass. The air shrinkage amounted to 7 per cent. In burning the bricklets incipient fusion occurred at 2150° F., with a total shrinkage of 14 per cent., and the color of the clay light buff. At about 2300° F. the shrinkage was 16 per cent., and the color yellow. Vitrification took place at 2350° F., and at this point the shrinkage had incresaed to 18 per cent., while the color had changed to grayish. Fusion took place at 2900° F.

The tensile strength is moderate, and varied from 100 to 110 pounds per square inch.

The ultimate composition is:

Analysis of Fire Clay, Woodstock, Bibb Co. (*No.* 111).

Silica	65.82
Alumina	24.58
Ferric oxide	1.25
Lime	——
Magnesia	tr.
Alkalies	.60
Ignition	8.165
	100.415
Total fluxes	1.85
Specific gravity	2.40

The rational analysis gave:

Clay substance	62.90
Feldspar Quartz	37.00
	99.90

(No. B).

FIRE CLAY,

AUXFORD'S, NEAR HULL'S STATION, TUSCALOOSA CO.

This is a sandy micaceous gray clay, with a slightly reddish tinge, which crumbles to pieces very quickly when immersed in water. When worked up it gives quite a plastic mass, and requires 33 per cent. of water to accomplish it.

The air shrinkage is from 9 to 10 per cent., and at 2000° F. the total shrinkage was only 12 per cent. At this latter temperature the bricklet was hard, grayish red in color, but still somewhat absorbent, while at about 2200° F. vitrification occurred, with a total shrinkage of 14 per cent. The viscosity occurred at

2500° F. The average tensile strength of the bricklet was 155 pounds per square inch, with a minimum of 140 pounds and a maximum of 168 pounds, which is very good.

The composition of the clay is as follows:

Analysis of Fire Clay, Hull's Station, Tuscaloosa Co. (No. B.)

Silica	61.25
Alumina	25.60
Ferric oxide	2.10
Lime	.25
Magnesia	.82
Alkalies	1.35
Ignition	8.10
	99.47
Total fluxes	4.52

(No. 118).

FIRE CLAY,

J. C. BEAN, TUSCALOOSA COUNTY.

It is a fine grained clay, with very little grit, and of homogeneous structure. When immersed in water it slakes with extreme slowness. The addition of 36 per cent. of water to the clay gives a very plastic mass and the bricklets made from this had an air shrinkage of 12 per cent.

When burned to 2200° F. the total shrinkage amounted to 18 per cent., the bricklet was grayish red in color, and very dense, incipient fusion having occurred. When heated to cone 27 in the Deville furnace it only vitrified.

The burning dense of this clay at such a temperature, and the great difference in temperature between the points of incipient sintering and vitrification are worthy of notice, and show it to possess character closely resembling those of many glass pot clays.

The composition of this clay is as follows:

Analysis of Fire Clay, Tuscaloosa Co. (No. 118).

Silica	58.13
Alumina	24.68
Ferric oxide	3.85
Lime	.15
Magnesia	.32
Alkalies	1.78
Ignition	11.78
	100.51
Total fluxes	5.92

The rational composition is:

Clay substance	60.85
Quartz	23.35
Feldspar	15.80
	100.00

Glass pot clays vary in chemical composition, and it is really the physical behavior of the material which it is of importance to know. At the same time the analyses of several other glass pot clays are given below for comparison.

Analysis of Glass Pot Clays

No. 1.

Silica	64.89
Alumina	24.08
Ferric oxide	.29
Lime	.41
Magnesia	.19
Potash	.87
Soda	.16
Ignition	9.29

No. 2.

Silica	55.61
Alumina	27.36
Ferric oxide	2.73
Lime	.87
Magnesia	.07
Alkalies	.71
Titanic oxide	1.36
Sulphuric acid*	.51
Moisture	2.26
Ignition	11.13
*Sulphur	.25

No 1 is from Layton Station, Pa. (1897 Report Pennsylvania State College, p. 90, T. C. Hopkins).

No. 2, St. Louis, Mo., Washed pot clay (Missouri Geological Survey Report, Vol. XI, p. 568.)

(No. 1).

FIRE CLAY,

PEARCE'S MILLS, MARION COUNTY.

This clay forms a bed from four to six feet thick in the ravine to the east of the mill. It is a hard rock-like material, and when mined has more the appearance of a white argillaceous sandstone than a clay. It is very hard, and when thrown into water practically does not slake at all, but it is very porous. When ground to 30 mesh and mixed with water it is very lean, but grinding it to 80 mesh increases the plasticity. In this latter condition it required 37 per cent. of water to work it up. The air shrinkage was 4 per cent., whereas when burned to 2100° F. it was 5 per cent., and at 2200° F. the total shrinkage was 7½ per cent., the color of the bricklet being still white like the original clay, but the porosity great. At about 2300° F. the bricklet developed a slightly grayish tint, and at 2400° the color was the same, but the total shrinkage 10 per cent Incipient fusion did not occur until heated to cone 27 in the Deville furnace. This is a very refractory clay, and one that has a comparatively low shrinkage, due to the large amount of silica in its composition.

Vitrification occurs at cone 30 and viscosity at cone 33 in the Deville furnace.

The composition of this clay is:

Analysis of Fire Clay, Pearce's Mill, Marion Co. (No. 1).

Silica	52.95
Alumina	35.10
Ferric oxide	.80
Lime	tr.
Magnesia	tr.
Alkalies	.93
Ignition	11.40
	101.18
Total fluxes	1.73

No. 2).

FIRE CLAY,

PEARCE'S MILLS, MARION COUNTY.

This sample is from a second opening which closely adjoins Pearce's Store, and like the other occurrence in this vicinity, it is very gritty, being even more so than the first, and while the material is very porous, at the same time it slakes very slowly, falling finally to a powdery mass. The fracture of the dry material is hard and angular, the air shrinkage is very low, amounting to only 2 per cent., in the case of sample which had passed through a 30-mesh sieve.

At 2350° F. the shrinkage is only 6 per cent., and the bricklet was creamy white in color, but still very absorbent. In the Deville furnace incipient fusion occurs at cone 27, vitrification at cone 32 and viscosity at cone 34.

The tensile strength is very low, ranging from 5 to 10 pounds.

The very refractory character of this clay is evident, but its leanness would no doubt necessitate its being mixed with a more plastic clay before it could be used.

(No. 57 S.)

FIRE CLAY,

J. W. WILLIAMS, PEGRAM, COLBERT COUNTY.

A black gritty clay, which slakes easily, considerable organic matter present, but no pyrite or mica noticeable.

It required 28.6 per cent. of water to make a workable mass, which, to the feel, was lean and gritty. Bricklets made of this shrank 10 per cent. in drying and 3 per cent. in burning, giving a total shrinkage of 13 per cent.

The average tensile strength of the air-dried briquettes was 46 pounds per square inch.

Incipient fusion occurs at 2150° F., vitrification at 2350° F., and viscosity at 2500° F.

The clay burns to a white body, slightly tinged with yellow.

The following is its chemical composition:

Analysis of Fire Clay, J. W. Williams, Pegram, Colbert Co. (No. 57, S.)

Moisture	1.70	
Silica (total)	80.55,	free sand 70.10
Alumina	10.50	
Ferric oxide	1.58	
Lime	.34	
Magnesia	traces	
Water and organic matter	5.85	
	100.47	
Total fluxes	1.87	

(No. C. S.)

FLINT CLAY,

CHOCTAW COUNTY.

A hard, fine grained, siliceous clay, resembling flint clay in appearance, but containing more silica than such material usually contains. It presents a smooth surface, with conchoidal fracture, and in water practically does not slake at all.

When ground to pass through a 30-mesh sieve it required 15 per cent. of water to make a workable paste and was very lean and granular. The tensile strength was, on the average, 5 pounds per square inch.

The shrinkage in drying was 2 per cent., and at 2300° F. 6 per cent. Incipient fusion occurs at 2300° F., vitrification at 2500° F. and viscosity at 2650° F.

On account of its refractory qualities and low shrinkage, this flinty clay is admirably adapted for admixture with plastic fire clays to serve as grog and prevent undesirable shrinkage. The following two analyses, No. 1, by W. B. Philips, and No. 2, by H. Ries, give the composition of this material:

Analysis of Fire Clay, Choctaw Co. (No. C. S.)

	(1)	(2)
Silica (total)	86.30	85.70
Alumina	5.12	6.15
Ferric oxide	1.60	1.80
Lime	.46	tr.
Water	6.60	7.00
	100.08	100.65
Total fluxes	2.06	1.80
Specify gravity		1.70

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*This is a Radiolarion clay, abundant in the Buhrstone division of the Tertiary formation in many localities in Choctaw, Washington, Clarke, Monroe and Conecuh counties. E. A. S.

POTTERY OR STONEWARE CLAYS.

Many clays which are too impure to be used as fire clays are often admirably adapted for pottery purposes. In fact stone ware clays are often somewhat intermediate in their nature between fire clays and pipe clays, that is to say they are too impure for the one purpose and too good for the other.

In the manufacture of stoneware, it is highly essential that the clay should burn to a dense impervious body without requiring too high a temperature to accomplish this, and furthermore if the ware is to be unglazed or is to be coated with a transparent glaze it is important that the clay should burn to a good uniform color. In order to obtain the desired result it is not uncommonly the rule to use a mixture of two or more clays for this purpose.

A stoneware clay should be smooth, and free from coarse grit, otherwise it may be necessary to wash the material, and thus increase the cost of manufacture. The clay, in addition, should be highly plastic in order to permit its being easily moulded without cracking, and the tensile strength should be not less than 150 pounds per square inch. As the ware is to be burned to a vitrified body, it is also desirable that there should be a difference of 150° to 250° F. between the point of vitrification and viscosity. (Earthenware clays are not vitrified.) Excessive plasitcity is undesirable as it necessitates very slow drying and burning of the ware and consequently increases the cost of manufacture; while on the other hand low shrinkage diminishes the loss from cracking or warping.

Iron is a desirable ingredient not only as it tends to give the body a good red color, but in addition serves as a flux. Lime if present as a silicate may form a desirable flux, but carbonate of lime especially if in greater quantities than two or three per cent. is objectionable, and sulphate of lime is likewise not desired as owing to its disassociation at high temperatures blisters may be formed.

A clay vitrifying at a low temperature is more desirable as it requires fuel to burn it.

The pottery clays reported on are all from the Tuscaloosa formation of the Lower Cretaceous except No. 204 from Blount county, and No. 192 from near Rock Run, both of which come from the Paleozoie limestone formations.

(No. 204.)

STONEWARE CLAY

FROM F. S. WHITE, BLOUNT CO.

A very fine grained sedimentary clay of grayish white color with occasional spots of yellow.

It slakes easily when thrown into water and works up to a very plastic mass with 28 per cent. of water. The bricklets made from this had an air shrinkage of 5 per cent.

Then burned at 2200° F. it is nearly dense, cream gray in color and showed a total shrinkage of 17 per cent.

At 2350° F. was vitrified and showed very light gray color and a total shrinkage of 20 per cent.

It fused at the time at cone 27 in the Deville furnace.

The tensile strength of the air dried briquettes was low, ranging from 45 pounds per square inch to 55 pounds per square inch.

The analysis of the clay yielded:

Analysis of Stoneware Clay, Blount Co. (No. 204).

Silica	61.50
Alumina	26.20
Ferric oxide	2.10
Lime	0.50
Magnesia	0.43
Alkalies	0.70
Ignition	7.29
	98.72
Total fluxes	3.73

While this clay is not highly refractory, at the same time it has about the right refractoriness to be used in the manufacture of stoneware, and owing to the dense body to which it burns, is excellently adapted probably to mix with more opened grained clays, which require a good binding material.

(No. 192.)

POTTERY CLAY

FROM C. C. DAVENPORT, ROCK RUN, CHEROKEE CO.

A green clay, of extreme fineness of grain, great density and breaking with a conschiodal fracture. In water it slackens rapidly to a flocculent mass.

It took 30 per cent of water to work it up and it yielded a lean and somewhat granular mass, which had an air skrinkage of 9 per cent.

The bricklets made from this clay burn to a greenish brown color, and vitrify easily at about 2000° F.

At about 1800° F. incipient fusion occurs, with total shrinkage of 18 per cent., and color brown. The clay fuses to a glassy mass at about 2150° F.

The average tensile strength of the air dried briquettes was 62 pounds per square inch, with a maximum of 70 pounds.

The analysis of the clay shows as follows:

Analysis of Pottery Clay, Rock Run, Cherokee Co. (No. 192).

Silica	57.00%
Alumina	17.80
Ferric oxide	5.60
Lime	2.10
Magnesia	1.20
Alkalies	6.00
Ignition	9.45
	99.15
Total	14.90

The high percentage of fluxes accounts for its easy fusibility, and the best use for this material would perhaps be as a natural glaze. It is exceedingly fine grained. When a slip is made of it and No. 205 (clay from near Kymulga) dipped into it, at cone 3-4 it yielded a transparent glaze.

CHALK BLUFF, ELMORE COUNTY.

At this locality there is a high bluff of clay and sand. The section involves approximately:

Section at Chalk Bluff, Elmore Co.

Sand	6 feet
Yellow clay	4 feet
Dark sandy clay	12 feet
Plastic clay	10 feet

Both the dark sandy, and lower plastic clay were tested and yielded very promising results. The lower bed yields a stoneware clay, and the upper a brick clay. (See Nos. 101 and 122.)

(No. 101.)

STONEWARE CLAY.

CHALK BLUFF, ELMORE CO.

This is a reddish gray fine grained clay, containing much fine mica and also an abundance of organic matter. In water it slakes very slowly. The addition of 38 per cent. of water to the air dried clay gives a fairly elastic mass, and bricklets made from this have an air shrinkage of 6 per cent. At 2100° F. the total shrinkage is 11 per cent., and the color of the burned clay is somewhat reddish. Incipient fusion occurs at this temperature, while vitrification takes place at 2200° F. with a total shrinkage of 13 per cent., the color of the clay when burned to this point being a dull red. Viscosity took place at 2600°, so that the clay is not to be classed as a fire clay, it would probably work however for vitrified ware. The tensile strength is exceedingly high, and runs from 300 to 384 pounds per square inch, and while there is considerable variation, at the same time even the lower figure is very great.

The chemical composition is:

Analysis of Stoneware Clay, Chalk Bluff, Elmore Co. (No. 101).

Silica	60.38
Alumina	20.21
Ferric oxide	6.16
Lime	.09
Magnesia	.720
Alkalies	1.80
Ignition	10.21
	99.570
Total fluxes	8.77

(Nos. 88 and 89.)

POTTERY CLAY.

McLEAN'S, EDGEWOOD, ELMORE CO.

Considerable clay is dug for pottery on the land of Mr. McLean, 4 miles from Prattville, along the line of the C. M. R. R. This clay occurs in large pockets surrounded by sand, it is chiefly of two kinds, i. e., a smooth plastic clay and a sandy one.

The former (No. 88) is very tough, and quite plastic.

In water it slakes in angular fragments, and when worked, requires 32 per cent. of water to develop its plasticity. The clay is rather fine grained, but with a conchidal fracture, and shows iron stains on its joint surfaces.

The tensile strength does not appear in this case to stand in direct relation to the plasticity, for the maximum is only 56 pounds per square inch, and the average 49 pounds.

The clay burns to a buff color, and a dense body, and is quite refractory.

The total shrinkage at 2350° F. is 18 per cent. At 2700 it is 18.05 per cent.

In the Deville furnace, at cone 30, the clay vitrified and showed no evidence of becoming viscous.

The second or sandy clay (No. 89) slakes very quickly. It gives a moderately plastic, but though not so tough a mass as the preceding. The tensile strength is however higher, being 74 pounds on the average, and 92 at the maximum.

The air shrinkage is 8.75 per cent; at 2200° F. the total shrinkage was 11 per cent.; at 2350° the total shrinkage was 12 per cent.

The clay fuses at cone 30 in the Deville furnace.

Associated with these stoneware clays is a bed of ochre which fuses easily to a brownish glass. Its composition is:

Analysis of Ochre, Edgewood, Elmore Co.

Silica	51.14
Alumina	30.13
Ferric oxide	8.35
Lime	tr.
Magnesia	tr.
Alkalies	tr.
Ignition	10.15
	99.77

(No. P. S.)

POTTERY CLAY (BLUISH.)

FROM McLEAN POTTERY, ELMORE CO.

A compact bluish clay which slakes rather quickly in water. It shows little grit to the taste. It required 20 per cent. of water to make a workable mass, which to the feel was smooth and plastic. This mud shrunk 6 per cent. in drying and an additional 6 per cent. in burning, giving a total shrinkage of 12 per cent. The average tensile strength of the air dried briquettes was 55 pounds per square inch with a maximum of 66 pounds. Incipient fusion occurred at 1950° F., vitrification at 2150° F. and viscosity at 2400° F.

The clay burns to a dense, smooth, bluish white body, and should make a good stoneware clay. In burning it had to be heated slowly.

The analysis of it is as follows:

Analysis of Pottery Clay, McLean's, Edgewood, Elmore Co. (No. P. S.)

Silica (total)	62.60
Alumina	26.98
Water	8.60
Ferric oxide	.72
Lime	.40
Magnesia	.36
Alkalies	.65
Moisture	.70
	101.01
Free silica	30.10
Total fluxes	2.13
Sepcifiy gravity	2.37

STONEWARE CLAY

FROM NEAR COOSADA, ELMORE CO.

This is a moderately fine grained but somewhat gritty clay, which however is quite plastic, requiring 26.25 per cent. of water to develop its plasticity.

The tensile strength was on the average 154 pounds, with a maximum of 170 pounds.

The air shrinkage amounted to 8.1 per cent.; at about 2200° F. the total shrinkage was 14 per cent., the clay at this temperature having burned nearly dense, and the brick being a brown gray color; at about 2300° F. the total shrinkage was 15 per cent., the brick was very hard, homogeneous, dense, and still of a brownish gray color though somewhat darker; at 2500° F. the brick was thoroughly vitrified, and showed a slight swelling, the shrinkage at this temperature being only 13.5 per cent. and the color remained unchanged except that it was slightly darker in shade. A test made of this clay in the Deville furnace showed that at cone 26 it had become viscous.

The composition of the clay is as follows:

Analysis of Stoneware Clay, Coosada, Elmore Co.

Silica	66.61
Alumina	21.04
Ferric oxide	2.88
Lime	.40
Magnesia	.58
Alkalies	.70
Water	7.00
	99.21
Total fluxes	4.46

(No. 1 S.)

POTTERY CLAY.

H. H. CRIBBS, TUSCALOOSA.

This is a whitish, fine grained clay with small amounts of grit, which slakes easily to small irregular grains and scales; it required 25 per cent. of water to mix it and gave a moderately plastic mass whose air shrinkage was 6 per cent. and fire shrinkage 4 per cent., giving a total shrinkage of 10 per cent.; briquettes made of this paste had, when air dried, a tensile strength of 68 pounds per square inch and a maximum tensile strength of 78 pounds per square inch.

Incipient fusion occurs at 2000° F., vitrification at 2200° F. and viscosity at 2400° F.

The clay burns to a dense yellowish body; the composition of it is as follows:

Analysis of Pottery Clay, H. H. Cribbs, Tuscaloosa (No. 1, S.)

Total silica	65.35
Alumina	21.30
Water	7.35
Ferric oxide	2.72
Lime	.60
Magnesia	.86
Alkalies	tr.
Moisture	1.44
	99.62
Free silica (sand)	39.25
Total fluxes	4.18
Specific gravity	2.34

Another analysis of this white clay from the Cribbs bed was made by Dr. Wm. B. Phillips and is as follows.

Analysis of White Plastic Clay, Cribbs Place, Tuscaloosa, Ala.

Silica	62.25
Alumina	27.90
Lime	2.36
Ferric oxide	0.10
Loss at red heat	10.00
	102.61
Total fluxes	2.46

If coarse grained this clay would probably work for a low grade of fire brick, as its fusibility would probably be less. It would probably work for potters clay, although it would no doubt be desirable to add a clay possessing greater plasticity and tensile strength to it.

The comparative purposes there are given herewith the tests of two Missouri clays quoted in Vol. XI of Missouri Geological Survey. The one has a much higher tensile strength however:

Analyses of Missouri Clays.

	1.	2.
Silica	65.32	66.26
Alumina	22.63	20.32
Water	7.42	7.80
Ferric oxide	1.81	2.30
Lime	.25	.63
Magnesia	.67	.48
Alkalies	1.72	2.04
Total fluxes	4.45	5.45
Incip. fusion	2000°	2000°F
Vitrification	2200°	2200°F
Viscosity	2400°	2400°F
Average tensile str., lbs. per sq. in	87	122
Maximum tensile strength	98	185

No. 1 is from Waltman's, Barton Co., used for stoneware.
No. 2 is from Lanigan shaft, Moberly, Randolph Co.

In composition it also resembles somewhat two clays from Ohio.*

Analysis of Ohio Clays.

	1.	2.
Combined silica	25.40	27.68
Free silica	40.81	36.58
Alumina	21.18	22.95
Water	6.29	6.74
Ferric oxide	1.28	1.28
Lime	.51	.45
Magnesia	.18	.37
Alkalies	1.80	1.96
Moisture	1.65	2.05
Total fluxes	4.77	5.86

No. 1. Cooking ware clay, Laresville, Muskingum Co.
No. 2. Stoneware clay, Akron, Summit Co.

In all of these analyses it will be noticed that the percentage of alkalies is higher, but the total fluxes are nearly the same, except in the last one.

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*O. Geol. Surv. VII, 1893.

In the case of the Ohio samples no physical tests have been made.

(No. 115.)

STONEWARE CLAY.

J. C. BEAN, TUSCALOOSA CO.

This is from the property of J. C. Bean, near Tuscalooso, in S. 31, T. 20, R. 11. The bed of clay is 6 feet thick and overlain by 4 feet of white sand.

It is a rather fine grained dense clay, which slakes very slowly. On mixing with 36 per cent. of water, it gave a very plastic mass, whose air shrinkage was 11 per cent., at 2200° F. the clay burned a pinkish brown and showed a total shrinkage of 16 per cent., while at 2250° F. it burned a grayish brown with a total shrinkage of 18 per cent. Incipient fusion occurs at 2100° F., vitrification at 2300° F. and viscosity at cone 27 in the Deville furnace. Owing to the extreme plastice nature of the clay it was very hard to make briquettes which did not show evidence of flaws so that the tensile strength ranged from only 90 to 100 pounds per square inch, which is probably low. Specific gravity 2.40.

(No. 100.)

POTTERY CLAY.

J. C. BEAN, TUCALOOSA CO.

This is a rather fine grained clay, and at the same time a dense one. It contains an appreciable quantity of organic matter which not only increases the plasticity but also necessitates slow drying and burning of the material. The addition of 31.5 per cent. of water to the clay converts it into a very plastic mass, whose shrinkage in air drying amounted to 9 per cent. In burning incipient fusion occurs at 2100° F., at which point the total shrinkage was 14 per cent. and the bricklet buff in color. At 2200° F. the shrinkage was 16 per cent and the bricklet grayish buff, while vitrification occurred at 2200° F. accompanied by a total shrinkage of 17 per cent. Viscosity took place at 2500° F. The tensile strength was only moderate, being 84 to 85 pounds.

The chemical composition is :

Analysis of Pottery Clay, J. C. Bean, Tuscaloosa Co. (No. 100).

Silica	60.03
Alumina	24.66
Ferric oxide	3.69
Lime	.13
Magnesia	.380
Alkalies	tr.
Ignition	11.342
	100.232
Total fluxes	4.20

(No. 32 S.)

STONEWARE CLAY.

ROBERTS' MILL, COAL FIRE CREEK, PICKENS CO.

A gray, tough, rather fine grained clay, which in water slakes somewhat slowly to a mixture of grain one-sixteenth to one-thirty-second of an inch in size. Taste gritty. Patches of fine sand and ore scattered through the clay, and associated with them are a few small flakes of white mica.

The clay when ground to 30 mesh and mixed with 21.8 per cent. water gave a workable mass of quite plastic character, which shrunk 4 per cent in drying and 8 per cent in burning, making a total shrinkage of 12 per cent.

Air dried briquettes of the clay had an average tensile strength of 117 pounds per square inch and a maximum strength of 142 pounds.

Incipient fusion occurred at 2000° F.; vitrification at 2200° F. and viscosity at 2400° F.

The clay burned to a stiff buff body, which deepens on hard firing.

The composition is as follows:

Analysis of Stoneware Clay, Roberts' Mill, Pickens Co. (No. 32 S.)

Silica (total)	68.23
Alumina	20.35
Water	6.10
Ferric oxide	3.20
Lime	.34
Magnesia	tr.
Alkalies	.74
Moisture	1.06
	100.02
Free silica (sand)	43.23
Total fluxes	4.28
Specific gravity	2.17

This clay might also serve for stoneware. It burns to a buff color.

In general composition this clay resembles somewhat a stoneware clay used at Zanesville, Ohio*, which is given below. It will be noticed however that while the per centage of total fluxes is very close, the individal ones differ somewhat in amount from those in the Alabama clay.

Analysis of Ohio Clay.

Silica (combined)	25.40
Alumina	21,18
Water	6.29
Ferric oxide	1.28
Lime	.51
Magnesia	.18
Alkalies	1.80
Moisture	1.65
	99.24
Free silica (sand)	40.81
Total fluxes	3.77

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*Ohio Geo. Surv. VII, 193.

(No. 11 S.)

POTTERY CLAY.

CRIBBS PLACE, BEDFORD, LAMAR CO.

A dark-colored, tough blue clay, containing much organic matter. It is very dense, and slakes very slowly. No pyrite and few mica scales were noticeable.

It requires 45 per cent. of water to make a workable mass, which was extrremely plastic and fat. This clay shrunk 12.5 per cent. in drying and an additional 6.5 per ceat. in burning giving a total shrinkage of 19 per cent., which is a large amoumt. The tensile strength of this air dried briquette should be great, but on account of the excessive plasticity it was found hard to mould briquettes which were free from flaws, so that most of them broke at about 100 pounds per square inch. Incipient fusion occurs at 1900° F. Vitrification at 2100° F. and viscosity at 2300° F. The clay burns to a deep red, dense body.

The following is the composition of it.

Analysis of Pottery Clay, Cribbs' Place, Lamar Co. (No. 11, S.)

Total silica	60.9
Alumina	18.98
Water and organic matter	12.46
Ferric oxide	7.68
Lime	trace
Magnesia	trace
Alkalies	trace
Moisture	.90
	100.92
Free silica (sand)	37.92
Total fluxes	7.68
Specific gravity	2.318

The chief use of this clay would probably be as a bond for leaner clays, in the manufacture of courser grades of pottery, or perhaps sewer-pipe.

In burning it has to be heated very slowly to prevent cracking, and the same holds true of the drying. Its excessive plasticily is in part due to the contained organic matter.

(No. 27 S.)

STONEWARE CLAY.

J. B. GREEN, FERNBANK, LAMAR CO,

A dense, fine grained, compact, tough clay, that falls to pieces extremely slowly in water. No pyrite noticeable. Taste somewhat gritty.

It required 32.6 per cent. of water to make it work up, giving a plastic mass. The shrinkage in drying was 10 per cent., and an additional 7 per cent. in burning, making a total shrinkage of 17 per cent. The tensile strength as determined by pulling apart air dried briquettes of the clay was on the average 152 pounds per square inch with a maximum of 185 pounds per square inch.

Incipient fusion occurs at 1900° F., vitrification at 2100° F., viscosity at 2300° F.

The clay burns to a hard, impervious body, of a deep red color. There is considerable organic matter present in the clay, which adds somewhat to the plasticity.

The analysis of the clay is as follows:

Analysis of Stoneware Clay, Fernbank, Lamar Co. (No. 27 S.)

Silica (total)	69.50
Alumina	13.00
Water and organic matter	6.70
Ferric oxide	6.40
Lime	.25
Magnesia	tr.
Alkalies	tr.
Moisture	3.40
	99.25
Free silica (sand)	43.90
Total impurities	6.65
Specific gravity	2.305

This clay would probably work very well for stoneware.

(No. 71 S.)

POTTERY CLAY.

W. DOTY, FAYETTE CO.

A fine grained, red clay, with little coarse grit, and very few mica scales. Slakes quickly to fine grains. It required 34.3 per cent of water to work it into a mass of good plasticily, the bricklets made from it shrinking 7 per cent. in drying and an additional 6 per cent in burning, giving a total shrinkage of 13 per cent.

The tensile strength of the air dried briquettes, was on the average; 116 pounds per square inch, with a maximum of 155 pounds.

Incipient fusion occurs at 2000° F., vitrication at 2200° F., and viscosity at 2400°.

It burns to a dense hard body of a nice deep red color, which darkens as vitrification is approached.

The composition of the clay is as follows:

Analysis of Pottery Clay, W. Doty, Fayette Co. (No. 71, S.)

Silica (total)	65.58
Alumina	19.23
Water	5.50
Ferric oxide	4.48
Lime	tr.
Magnesia	tr.
Moisture	1.40
	96.19
Free silica (sand)	45.85
Total fluxes	4.48
Specific gravity	2.42

(No. 70 S.)

POTTERY CLAY.

W. DOTY, FAYETTE CO.

A fine grained, rather gritty, reddish clay. In water it slakes quickly to small irregular grains. The addition of 25 per cent of water gave a plastic mass, which shrunk 6.2 per cent. in drying and an additional 5.8 per cent. in burning, giving a total shrinkage of 12 per cent.

Briquettes of the air dried clay had an average tensile strength of 95 pounds per square inch, and a maximum of 151 pounds.

Incipient fusion occurred at 2000° F., and viscosity at 2400° F. The clay burns to a yellowish color at 2000°, but to a red at 2200°. The body of the burned clay is smooth and dense.

The clay analyzed as follows:

Analysis of Pottery Clay, W. Doty, Faette Co. (No. 70 S.)

Silica (total)	67.10
Alumina	19.37
Water	6.08
Ferric oxide	2.88
Lime	tr.
Magnesia	.725
Alkalies	.672
Moisture	1.71
	98.537
Free silica (sand)	43.93
Total fluxes	4.27
Specified gravity	2.416

In compositon this clay resembles some-what a clay used for pottery and sewer pipe, and obtained at Gilkerson Ford, Henry Co., Mo.*

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*Mo. Geol. Survey XI, p. 328.

The composition of this clay is:

Analysis of Clay, Henry Co., Mo.

Silica	67.49
Alumina	21.11
Water	5.95
Ferric oxide	2.45
Lime	.17
Magnesia	.63
Alkalies	2.83
	100.63
Total fluxes	6.08
Specific gravity	2.28

The shrinkage in both drying and burning is six per cent. and the tensile strength in 110 on the average, with a maximum of 127. Incipient fusion begins at 2000° F. complete vitrification at 2300°F., and viscosity at 2400° F.

(No. 68 S.)

POTTERY CLAY (REFRACTORY).

SHIRLEY S MILL, FAYETTE CO.

A fine grained, compact clay, with little coarse grit, but considerable fine sand. Color drab. It slakes very slowly to scaly grains.

Three per cent. of water were required to make a workable paste which was quite plastic. This paste shrunk 10 per cent. in drying and 4 per cent. in burning, giving a total shrinkage of 14 per cent.

The tensile strength of the air dried briquettes showed an average of 106 lbs. per square inch, and a maximum of 123 lbs.

The clay burns to a yellowish white body. Incipient fusion occurs at 2000° F., vitrification at 2200° F., and viscosity at 2400° F., The composition of the clay is as given below:

Analysis of Refractory Pottery Clay, Shirley's Mill, Fayette Co., (No. 68 S.)

Silica (total)	72.20
Alumina	17.42
Water and loss	7.40
Ferric oxide	2.40
Lime	trace
Magnesia	trace
Alkalies	.56
Moisture	.12
	100.10
Free silica (sand)	52.31
Total fluxes	2.96
Specific gravity	2.28

This clay might work for an inferior grade of fire brick, or also for pressed brick of a light color, or even for potter's clay. It resembles rather closely in composition a stoneware clay from Commerce, Scott Co., Missouri,* agreeing closely in every respect except the tensile strength. For sake of comparison the properties of the Commerce clay are given herewith:

Analysis of Clay, Commerce, Mo.

Silica	71.78
Alumina	17.01
Water	8.13
Ferric oxide	2.01
Lime	.34
Magnesia	.43
Alkalies	.78
	100.48
Total fluxes	3.56
Specified gravity	2.03
Incipient fusion	2000° F.
Vitrificaton	2200° F.
Viscosity	2400° F.
Average tensile strength	225 lbs. per sq. inch
Maximum tensile strength	254 lbs. per sq. inch

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*Mo. Geol. Survey, XI, 350.

(No. 23 S.)

STONEWARE CLAY.

HEZEKIAH WIGGINS, FAYETTE CO.

A light gray, hard, compact clay, of moderately silicious character and containing a few scattered mica scales. It slakes very slowly to tough scaly flakes.

In order to make a workable paste the clay required the addition of 34.3 per cent. of water. This paste was markedly plastic. Its shrinkage in drying was 14 per cent. and 8 per cent. in burning, giving a total shrinkage of 22 per cent. The tenacity of the air dried mass was on the agerage 232 lbs. per square inch with a maximum of 300 lbs. per square inch; which is exceeded by comparatively few clays.

Incipient fusion occurs at 1900° F., vitrification at 2100° F., and viscosity at 2300° F. The clay burns to a dense red body, but requires slow drying and heating to avoid cracking.

The composition of this clay is as follows:

Analysis of Stoneware Clay, H. Wiggins, Fayette Co. (No. 23 S.)

Silica (total)	63.27
Alumina	19.68
Water	6.05
Ferric oxide	3.52
Lime	1.30
Magnesia	tr.
Alkalies	1.20
Moisture	3.75
	98.77
Free silica (sand)	39.59
Total fluxes	**6.02**
Specific gravity	**2.32**

The clay agrees in composition in a general way with some of the stoneware clays of Missouri and Ohio, and its shrinkage and tensile strength are similiar to a ston ware clay from Harrisonville, Cass Co., Mo.,* but the latter having nearly 3 per cent. more fluxes fuses at a lower temperature.

(No. 65a. S.)

POTTERY CLAY.

TEN MILES SOUTHEAST OF HAMILTON, MARION CO.

A moderately gritly, medium grained clay with a few mica scales, it required 28.9 per cent. of water to make a workable mass, which is rather lean. The air shrinkage of bricklets made from this was 6.5 per cent. with an additional shrinkage of 5.5 per cent. in burning, making a total shrinkage 12 per cent.

The average tensile strength of air dried briquettes was 58 lbs. per sq. inch with a maximum of 6.5 lbs. per square inch.

Incipient fusion occurs at 1950° F., vitrification at 2150° F., and viscosity at 2350° F.

It burns to a grayish buff color.

The chemical composition is as follows:

Analysis of Pottery Clay, 10 miles southeast of Hamilton, Marion Co. (No. 65a, S.)

Silica (total)	70.00
Alumina	21.31
Water	6.35
Ferric oxide	2.88
Lime	.20
Magnesia	tr.
Alkalies	tr.
Moisture	.50
	101.24
Free silica (sand)	45.80
Total fluxes	8.08
Specific gravity	2.10

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*Mo. Geol. Survey XI, p. 315.

(No. 62 S.)

POTTERY CLAY.

THOMAS ROLLINS, FRANKLIN CO.

A fine-grained tough clay, which slakes very slowly when thrown into water, but splits very easily along thin sandy layers which occur at intervals of about every half inch, a few mica scales are present, the addition of 20 per cent. of water gave a workable and quiet plastic paste.

The shrinkage of bricklets made from this paste was 10 per cent. in drying, and 4 per cent. in burning, or a total of 14 per cent.

The average tensile strength of air dried briquettes was 102 lbs.per square inch, with a maximum of 127 lbs. per square inch.

Incipient fusion occurs at 1900° F., vitrification at 2100° F., and viscosity at 2300° F. The clay burns to a red-gray, but has to be heated very slowly,

The composition of the clay is as follows:

Analysis of Pottery Clay, Thomas Rollins, Franklin Co. (No. 62, S.)

Total silica	67.50
Alumina	19.84
Water	6.15
Ferric oxide	6.15
Lime	.12
Magnesia	.10
Moisture	1.50
Total	100.97
Free silica (sand)	43.46
Total fluxes	5.90
Specific gravity	2.36

(No. 55 S.)

POTTERY CLAY (REFRACTORY.)

J. W. WILLIAMS, PEGRAM, COLBERT CO.

A white clay of fine grain, which slakes easily in water. The addition of 26 per cent. of water gave a lean workable mass which shrunk 5 per cent. in drying, and 10 per cent. in burning, giving a total shrinkage of 15 per cent. The average tensile strength of air dried briquettes per sq. inch is 30 lbs, and the maximum tensile strength per sq. inch is 35 lbs.

Incipient fusion occurs at 2150 F., vitrificataon at 2300 F., and viscosity at 2500 F.; the clay burns to a dense yellowish white body.

Following is the composition of the clay:

Analysis of Pottery Clay J. W. Williams, Pegram, Colbert Co. (No. 55 S.)

Total silica	66.45
Alumina	18.53
Ferric oxide	2.40
Water	8.68
Lime	1.50
Magnesia	1.25
Alkalies	tr.
Moisture	.78
	99.59
Free silica (sand)	44.22
Total fluxes	5.15
Clay base	49.44
Specific gravity	2.39

This clay could probably be purified by washing, it corresponds in general composition to a fire clay from Parker and Russel's Mine* near St. Louis Mo., but the latter on account of its greater coarseness, has a larger refractoriness.

BRICK CLAYS.

The term brick clays is a somewhat elastic one for it may include those used for the manufacture of common brick, front or pressed brick, and paving brick. As the requirements are somewhat different they can be mentioned briefly and apart.

Clays for common brick. For this purpose almost any clay suffices, in fact so little attention is applied to material used for this purpose, that the product is often soft and porous. Clays for common brick should not be excessively sandy, otherwise the brick will be weak and porous. They should possess sufficient plasticity to mould without cracking, but not be so plastic as to warp, due to excessive shrinkage. Most brick clays burn red. Ferruginous clays can be more safely burned to a hard product than clacareous ones, which burn buff or cream colored.

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*Missouri Geol. Survey. Vol. XI, p. 570.

The methods used for moulding common brick are the *soft mud*, by which the soft plastic mass is forced into the mould; and *the stiff mud*, in which the clay is forced from a die of rectangular cross section and then cut up into bricks. The latter method gives greater capacity, but the bricks unless thoroughly burned will not stand the weather as well. Very plastic clays and very lean ones are adapted to the stiff mud process, the former because they are not tenacious enough, the latter because owing to their pastiness and the structure of the machine a laminated structure is developed in the brick.

Brick clays should have a tensile strength not less than 50 lbs. per square inch. They are not required to stand a high degree of heat, a few common brick kilns attain a temperature of over 1800 or 1900 degrees Fahr.

The more rapidly the clay slakes the easier will it be to temper it.

Clays for front or pressed brick. For this purpose a lighter grade of clay is required, and the material must not only burn to a hard body but also to a uniform color, for on the latter depends much of the beauty of the structure. In no branch of the clay working industry is the range of colors producible from natural clay mixtures more carefully considered than in the manufacture of pressed brick.

Many shades are obtained either by mixing two or more clays, or by adding artificial coloring agents to the raw materials.

Clays for front brick should shrink evenly in burning, and not warp nor crack. Straightness of outline and evenness of size are essential to close fitting when set in the wall.

Many front brick are moulded by the dry-press process, in which the clay is forced into the mould in the form of a dry powder. Such bricks have straight edges and smooth surfaces, but unless burned good and hard they chip easily. At many localities the clay is moulded in soft mud or stiff mud machines, and the brick, while still soft, repressed in a second machine whereby the surfaces are smoothed even and the edges straightened. These latter brick do not tend to exhibit the same brittleness along the edges as the dry press brick are apt to.

Front brick sell from $15.00 to $70.00 per 1000, depending on the color and shape.

Clays for paving brick. The nature of these must be such that they can be burned to vitrification. To do this economically and on a large scale the points of vitrification and viscosity should be at least 125° F. apart and preferably 200° F. If they were not it would be impossible to bring a kiln full of bricks to vitrification without running them up to the temperature of viscosity. For this reason calcareous clays are not well adapted to paving brick manufacture.

Paving brick clays should possess moderate or good plasticity so that they can be moulded by the stiff mud process, and while it is desirable that the tensile strength should be 75 pounds or more, at the same time many good pavers are made from mixtures whose tensile strength is not over 50 pounds per square inch.

Shales are used to a large extent for the manufacture of paving brick, partly because many of them contain about the right quantity and kind of fluxing impurities, and also because, owing to the fineness of grain, they vitrify more evenly and thoroughly.

Paving brick are at times made from fireclay, and the results obtained are excellent, but still shale is the favored material.

Except for comparing brick made from the same deposit, the color is absolutely no indication of the quality of a paving brick.

The important properties which a paving brick should show are low absorption (under 2 per cent.) and resistance to abrasion. Crushing strength is of little importance provided it exceeds say 8,000 pounds per square inch.

The brick clays described below come from several geological formations. The Graves' shales, Nos. 107 and 108; the Coaldale shale and the Pearce Mill shale, No. 3, are Carboniferous shales. The Dixie clay and No. 128 and 129 of Mr. Stevens, are from the Poleozoic limestones, while the rest, No. 110 from Shirley's Mill, No. 122 from Chalk Bluff, Elmore Co.; No. 126 of Mr. Stevens, from Woodstock; No. A, from Tusealoosa Co., are from the Tuscaloosa formation of the Sower Cretaceous.

(Nos. 107 and 108.)

BRICK-SHALES.

W. H. GRAVES, BIRMINGHAM, JEFFERSON CO.

Associated with the coal on the property of Mr. W. H. Graves are two beds of shale, viz: a yellow, sandy shale, and a gray one containing much less grit. Both of these were tested physically and the results of these tests are given below. The yellow shale contains a high per centage of ferric oxide and fuses very easily, while the gray shale contains several per cent. less, and is much better adapted to the manufacture of vitrified wares. The composition and physical characters of the two are given side by side for the purposes of comparison.

Light or gray shale, No. 108.

Plasticity, quite good. The shale takes 25 per cent. of water to work it up.

Air shrinkage 2 per cent.

Shrinkage at 2000° F., 9 per cent. Brick good red color not, very porous.

Shrinkage at 2200° F., 12 per cent. Brick reddish brown, and just about vitrified.

Fusion a 2500° F.

Tensile strength—average 105 pounds, minimum 85 pounds per square inch.

Dark or yellow shale, No. 107.

Plasticity moderate; shale gritty, requires 20 per cent. of water to work it up.

Air shrinkage 1½ per cent.

Shrinkage at 2000° F., 5 per cent. Brick good red color. Somewhat porous.

Shrinkage at 2150° F., 6½ per cent, Brick nearly dense, reddish towards brown.

At 2250° F., nearly vitrified.

Fusion at 2500° F.

Tensile strength only 40 pounds to square inch.

Analysis of shales, Birmingham, Jefferson Co. (No. 107 and 108.)

	(108)	(107)
Silica	57.80	61.55
Alumina	25.00	20.25
Ferric oxide	4.00	7.23
Lime	2.10	tr.
Magnesia	80	.986
Ignition	7.50	6.19
Alkalies	1.80	2.25
	99.00	98.466
Total fluxes	8.70	8.45
Specific gravity	2.12	2.23

The gray shale burns to a denser, harder body than the yellow, and does not blister as easily in burning owing to its lower per centage of iron.

PAVING BRICKS SHALE,

COALDALE, ALA.

A yellowish red, soft shale, with considerable grit. No mica or pyrite noticeable.

Ground to 30 mesh and mixed with 22 per cent. of water it gave a lean paste, which shrunk 4 per cent. in drying and 5.5 per cent. in burning, giving a total shrinkage of 9.5 per cent.

The tensile strength of the air dried briquettes was on the average of 25 pounds per square inch with a maximum of 35 pounds.

Incipient fusion occurs at 1900° F., vitrification at 2000° F., and viscosity at 2150° F.

The shale burns to a red body and makes a good red brick. It is also used for paving brick.

(No. 33.)

RED SHALE,

PEARCE'S MILLS, MARION CO.

There is an an extensive outcrop of partially weathered Carboniferous shale along the private road of Mr. Pearce just before reaching the millls. It is a red, rather fine grained material, and contains a small amount of mica. Its soft character renders the mining of it an easy matter. When ground the shale gives a moderately plastic mass whose plasticity could no doubt be increased by weathering. Forty per cent. of water were required to work it up, and the bricklets made from this material had an air shrinkage of 4 per cent. When burned to 2000°

F., the total shrinkage was 8 per cent., and the color of the bricklet was a rich red. At 2100° F., the color of the bricklet was the same, and the shrinkage was 9 per cent., incipient fusion having occurred at this point. Vitrification occurs at 2200° F., and the color is deep red, while viscosity took place at about 2300° F. In drying the clay showed little evidence of containing any appreciable quantity of soluble salts that would tend to form any efflorescence, nor did any show themselves afetr burning.

The comparatively small shrinkage and the rich red color to which the clay burns would make it admirably adapted to the manufacture of pressed brick, but unless it was mixed with a more plastic clay it would hardly work for the production of terra cotta.

The semi-weathered character of the material would also facilitate the preparation of it.

(No. A.)

PAVING BRICK CLAY,

TEN MILE CUT, TUSCALOOSA CO.

The sample of this clay was collected by the writer from what is known as the Ten Mile Cut on the M. & O. R. R., west of Tuscaloosa. It is a somewhat gritty clay, which contains thin seams of sand. The general color of the clay is bluish-gray, but here and there it shows stains of limonite especially on the sandy fractures. When thrown into water it slakes and gives in working a somewhat gritty, but quite plastic mass, which requires 26.00 per cent. of water to work it up.

The air shrinkage of the clay amounted to 8½ per cent. while at 2200° F., it was only 10 per cent., and at 2300° F., 12 per cent., at which point incipient fusion occurred.

Vitrification took place at cone 27 in the Deville furnace and fusion above cone 30.

The tensile strength of the air dried briquettes varied from 126 to 144 pounds per square inch with an average of 140 pounds. The clay burns to a buff color, and is to be classed as a refractory one although it is not highly so. Its location is excellent for cheap working, and easy shipment of the product, and while it has been put under the head of paving brick clays there is no reason why it should not find uses in other directions as well.

The chemical composition of this clay is as follows:

Analysis of Paving Brick Clay, Tuscaloosa Co. (No. A.)

Silica	72.70
Alumina	19.61
Ferric oxide	.934
Alkalies	.80
Ignition	6.50
	100.544
Total fluxes	1.734

PRESSED BRICK CLAY,

DIXIE POTTERY CO., OXFORD, CALHOUN CO.

This is the clay used by the Dixie Tile and Pottery Co. For the manufacturer of buff brick, the clay is quite plastic, and considering this fact it does not seem to require an extraordinary amount of water to work it up. The amount used being only 25.75 per cent. The average tensile strength is 130 pounds per square inch, with a maximum of 144 pounds. In air drying the clay shrunk about 10 per cent; at about 2200° F. incipient fusion began, and up to this point the clay had burned a buff color but then began to burn to a grayish tint; vitrification took place at 2400°, and the total shrinkage to this point was

18 per cent. The clay fused or became viscous at 2600° F. The following is a composition of it:

Analysis of Pressed Brick Clay, Oxford, Calhoun Co.

Silica	71.30
Alumina	17.16
Ferric oxide	1.94
Lime	.60
Magnesia	.43
Alkalies	.95
Ignition	7.60
	99.98
Total fluxes	3.92

This clay should make a good buff colored ware if burned at a comparatively low temperature, but if burned to vitrification the color would of course be much darker as indicated by the test, and owing to the high shrinkage in burning it would be necessary to conduct the latter slowly and with care to prevent cracking of the clay.*

(No. 110.)

PRESSED BRICK CLAY.

SHIRLEY'S MILL, FAYETTE CO.

The clay from this locality is a very fine grained dense one, but at the same time breaks up very easily.

It took 33 per cent. of water to work it up, and the air shrinkage of the bricklets was 6 per cent.

Incipient fusion occurs at 2100° F.

Vitrification took place at 2200° F. and at this point, the bricklet showed a total shrinkage of 16 per cent., and a deep cream color.

In the Deville furnace, at cone 27, the clay became viscous.

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*These bricks are well known in Alabama, and deserve to be even more generally usd than they are. E. A S.

While this clay is not to be looked upon as a refractory one, it would seem that owing to the beautiful color, to which it burns, it would be highly desirable for the manufacture of pressed brick.

The composition of the clay is:

***Analysis** of **Pressed Brick Clay, Shirley's Mill, Fayette Co.** (No. 110.)*

Silica	71.32
Alumina	20.10
Ferric oxide	1.05
Lime	tr.
Magnesia	.316
Alkalies	tr.
Ignition	7.505
	100.291
Total fluxes	1.366
Specific gravity	1.90

(No. 122.)

BRICK CLAY.

CHALK BLUFF, ELMORE CO.

The upper half of the clay bed at this locality is composed of a dark, dense, grayish brown clay which contains a large amount of organic matter, either in a finely divided condition or in the form of leaves. Although not sandy, at the same time it is rather lean when mixed up with water, and owing to the presence of so much organic material absorbed 40 per cent. of water when it was being worked up to a plastic mass. The air shrinkage was however only 6 per cent. At 1900° F. it had reached a total of 14 per cent., but the bricklet was still very absorbent; at 2100° F. incipient fusion had been reached and the total shrinkage was 18.7 per cent., while the color was brownish red; and at about 2200° F. the total shrinkage was 20 per cent. and the color brown, and this color had deepened considerably at 2250° F. with the ap-

appearance of vitrification ,while the maximum shrinkage amounted to 21 per cent. Viscosity was obtained in the Deville furnace at cone 27.

This clay therefore shows an appreciable and safe distance between vitrification and viscosity. The tensile strength is however low, averaging 75 pounds per square inch, with a maximum of 97 pounds per square inch, and a minimum of 68 pounds. Specific gravity, 2.41.

(No. 26 A. Stevens.)

BRICK CLAY.

WOOKSTOCK, BIBB CO.

This is quite a plastic clay, which requires 29 per cent. of water to produce its maximum plasticity. The air shrinkage was 6 per cent., and the average tensile strength was 101 pounds per square inch, with the maximum of 104 pounds. The fire test gave the following results:

At 2250° F., the shrinkage 10 per cent, clay incipiently fused, color buff.

At 2400° F., shrinkage 11 per cent., color a dark buff.

At 2500° F., clay vitrified, color reddish.

Viscosity occurs at cone 27 in the Deville furnace.

The composition of the clay is:

Analysis of Brick Clay, Woodstock, Bibb Co. (No. 126 A. Stevens.)

Silica	74.20
Alumina	17.25
Ferric oxide	1.22
Lime	.30
Magnesia	.40
Alkalies	tr.
Ignition	7.35
	100.72
Total fluxes	1.92

(No. 129, Stevens.)

BRICK CLAY.

BIRMINGHAM.

This is a very dense hard clay; which required considerable grinding to break it up. The different lots were mixed up, and the one, A, being composed of two-fifths of the clay which was passed through 20 mesh sieve, and thee-fifths of particles greater than 20 mesh.

The second lot, B, was made up entirely of that which had passed through the 20 mesh sieve.

Both lots gave a rather lean mass, but A required 19 per cent. of water and B 16 per cent. to work up. The average tensile strength of A is 12 pounds, and that of B 35 pounds. The air shrinkage of both was 4 per cent.

In burning to 2300° F. the shrinkage of A was 3 per cent, the color of the bricklet a full yellow, and the body very absorbent. At 2400° F. incipient fusion occurred in both cases, and the color of the bricklet was a brownish gray, and the total shrinkage 10 per cent.

At 2500° F. the clay was vitrified, of a dull brownish gray color, and showed a very homogeneous fracture.

Viscosity occurred at 2700° F.

The chemical composition of the clay is:

Analysis of Brick Clay, Birmingham. (No. 129 Stevens.)

Silica	67.30
Alumina	16.10
Ferric oxide	7.77
Lime	tr.
Magnesia	tr.
Alkalies	tr.
Ignition	9.25
Total fluxes	100.42

(No. 128, Stevens.)

BRICK CLAY.

ARGO, JEFFERSON CO.

This was a very plastic smooth clay, which took 22.20 per cent. of water to work it up. The tensile strength varied from 120 to 136 pounds per square inch. The air shrinkage was 7½ per cent. The behavior of the clay at other temperatures was as follows:

At 2250° F. the shrinkage was 12 per cent., color yellowish gray.

At 2300° F. the shrinkage and the color the same, but incipient fusion had begun.

At 2500° F. the clay was vitrified, and the total shrinkage was 14 per cent. In the Deville furnace, at cone 27, the clay became thoroughly viscous.

It could not therefore be called a very refractory clay, but would work no doubt very well for pressed brick or for other purposes.

The composition of the clay is as follows:

Analysis of Brick Clay, Argo, Jefferson Co. **(No. 128 Stevens.)**

Silica	72.87
Alumina	18.03
Ferric oxide	2.00
Lime	.61
Magnesia	.42
Alkalies	.53
Ignition	6.62
	101.08
Total fluxes	3.56

MISCELLANEOUS CLAYS.

These are all derived from the Tuscaloosa formation of the lower Cretaceous.

(No. 67 S.)

CLAY FROM W. D. BAGWELL'S,

SEVEN MILES NORTH OF FAYETTE COURT HOUSE, FAYETTE CO.

A gritty clay, that slakes slowly but completely to fine grains.

The clay required 28 per cent. of water to make a washable mass, which was slightly plastic and gritty. This paste shrunk 6 per cent. in drying and 3 per cent. in burning, giving a total shrinkage of 9 per cent.

The average tensile strength of the air dried briquettes was 45 pounds per square inch, with a maximum of 53 pounds.

Incipient fusion occurred at 2100° F., vitrification at 2250° F., and viscosity at 2409° F.

The clay burns to a deep buff color.

Its composition is as follows:

Analysis of Clay from W. D. Bagwell, Fayette Co. (No. 67. S.)

Silica (total)	75.70
Alumina	14.36
Water	4.45
Ferric oxide	4.64
Lime	tr.
Magnesia	tr.
Moisture	1.24
	100.39
Free silica (sand)	58.60
Total fluxes	4.64
Specific gravity	2.26

(No. 40 S.)

CLAY FROM H. PALMER,

BEXAR, MARION CO.

A gritty, fine grained clay, containing scales of mica, which slakes easily and quickly to irregular grains.

It required 26 per cent of water to make a workable paste, which to the feel was very slightly plastic and it tasted gritty. In shrinkage in drying was 6 per cent. and 3 per cent. in burning, making a total shrinkage of 9 per cent.

Air dried briquettes of the mud had an average tensile strength of 66 pounds per square inch, and a maximum tensile strength of 68 pounds per square inch.

Incipient fusion occurred at 2000° F.; vitrification at 2160° F. and viscosity at 2300° F.; at 2000° F. it burns to a buff, but on retrifying it becomes red in color.

The composition of the clay is as follows:

Analysis of Clay, H. Palmer, Bexar, Marion Co. (No. 40 S.)

Silica (total)	71.33
Alumina	21.88
Water	5.54
Ferric oxide	.32
Lime	.234
Magnesia	.305
Moisture	1.05
	100.659
Free silica (sand)	46.45
Fluxes	.859
Specific gravity	2.305

(No. 12.)

CLAY FROM H. PALMER,

BEXAR, MARION CO.

A fine grained clay, with sandy laminae and mica scales between the layers. It slakes slowly to fine particles and grains of sand.

The clay required the addition of 31 per cent. of water and gave a moderately plastic mass, that shrank 5 per cent. in drying and 3 per cent. in burning, making a total shrinkage of 8 per cent. The briquettes made from this paste had, when air dried, an average tensile strength of 85 pounds per square inch, with a maximum of 89 pounds per square inch.

Incipient fusion occurs at 1950° F., complete vitrification at 2150° F., and viscosity at 2350° F. The clay burns to a yellowish red body.

Its composition is as follows:

Analysis of Clay, H. Palmer, Bexar, Marion Co. (No. 12)

Total silica	69.93
Alumina	20.15
Water	5.90
Ferric oxide	1.38
Lime	.42
Magnesia	tr.
Alkalies	tr.
Moisture	1.20
	98.98
Total fluxes	1.80
Specific gravity	2.28

(No 41 S.)

MOTTLED CLAY.

BEXAR, MARION CO.

A very open grained, sandy clay, with scattered scales of mica and occasional iron stains. It slakes very quickly to its component mineral grains.

It required 39 per cent. of water to work it up. It is slightly plastic, and shrunk 6 per cent. in drying with an additional 11 per cent. in burning, making a total shrinkage of 17 per cent.

Air dried briquettes of the mud had an average tensile strength of 15 lbs. per square inch, and a maximum of 80 lbs. per square inch.

Incipient fusion occurs of 2000° F., vitrification at 2150° F., and viscosity at 2300. The clay burns to a red, but not very smooth body.

The clay analyzed as follows:

Analysis of Mottled Clay, Bexar, Marion Co. (*No. 41 S.*)

Silica (total)	72.40
Alumina	14.86
Water	5.05
Ferric oxide	7.64
Lime	.20
Magnesia	.40
Moisture	.65
	101.20
Free silica (sand)	55.20
Fluxes	8.24
Specific gravity	2.445

(No. 18 S.)

BLUE CLAY.

THIRD CUT NEAR GLEN ALLEN, MARION CO.

A very fine-grained soft clay with little grit, which slakes very readily on being thrown into water.

It required 28 per cent. of water to make a workable mass which was slightly plastic. The shrinkage of this paste in drying was 8.3 per cent., and in burning 7 per cent., giving a total shrinkage of 15.3 per cent. The tensile strength of the air dried briquettes was 56 lbs. per square inch on the average, with a maximum of 65 lbs. per square inch.

Incipient fusion occurs at 1950° F., vitrification at 2150° F., and viscosity at 2350° F.

The clay burns to a light bluff.

The composition on analysis was found to be as follows:

Analysis of Blue Clay, R. R. Cut, near Glen Allen, Marion Co. (No. 18 S.)

Silica (total)	68.10
Alumina	21.89
Water	5.05
Ferric oxide	2.01
Lime	.80
Magnesia	.28
Alkalies	.40
Moisture	.70
	99.230
Free silica (sand)	41.60
Total	4.19
Specific gravity	2.44

The fineness of grain is probably accountable for the low tensile strength and comparatively low temperature of vitrification and fusion. As far as the composition is concerned it is not unlike some of the potters clays used it the United States, but its low tensile strength would probably act against its utility for this purpose, unless mixed with a more plastic clay. For building materials it would no doubt work all right. Being of fine uniform grain permits the production of a very smooth surface on the ware.

(No. X. S.)

CLAY FROM W. J. BECKWITH'S.

COLBERT CO.

A moderately fine-grained, homogeneous, brittle, porous clay, with a semi-couchoidal fracture. In water it slakes slowly to particles mostly under one-sixteenth inch in size.

When mixed with 28 per. cent. of water it gave a lean mass of somewhat gritty feel, which shrunk 5 per cent. in drying and 6 per cent. in burning, or a total shrinkage of 11 per cent. The clay had to be dried and burned slowly to prevent cracking.

Air dried briquettes made of the mud had an average tensile strength of 22 lbs. per square inch, and a maximum strength of 38 lbs.

Incipient fusion occurs at 2050° F., vitrification at 2250° F., and viscosity at 2450° F.

The clay burns to a deep buff body, and requires careful heating to avoid cracking.

An analysis of the material gave the following results:

Analysis of Clay, W. J. Beckwith, Colbert Co. (No. X 8.)

Silica (total)	58.20
Alumina	29.86
Water	9.12
Magnesia	tr.
Lime	.20
Ferric oxide	2.22
Alkalies	tr.
Moisture	1.18
	100.78
Free silica	22.59
Total fluxes	2.44
Specific gravity	2.18

THE UTILIZATION OF CLAY FOR PORTLAND CEMENT.

Aside from being used for the manufacture of clay products, there remains the possibility of using some of the Alabama clays for the manufacture of Portland cement. The three essential elements of this material are lime, silica and alumina. The first of these is supplied by limestone, marl or chalk, while the other two are contained in clay.

In the manufacture of Portland cement the two materials are ground and intimantely mixed after which they are burned to vitrification. During the burning certain compounds are formed, especially calcic aluminates and silicates, whose union with water and subesquent crystallization causes the cement to set. The mixture of clay and limestone is manipulated so that in the finished product, the per centage of lime shall be equal to 2.8 times the silica plus 1.1 times the alumina and to maintain this constancy requires that the composition of the materials used must be constantly watched.

While it is possible to get a proper cement mixture from materials showing an appreciable range in composition, at the same time care must be exercised. Highly siliceous clays or limestones are undesirable, the materials used often contain ferric oxide, magnesia or alkalies.

Their affect according to Shewberry is as follows: Ferric oxide combines with lime at a high heat and acts like alumina in promoting combinations of silica and lime. For practical purposes the presence of ferric oxide in a clay need not be considered in calculating the amount of lime required.

Alkalies so far as indicated by the behavior of soda, are of no value in promoting the combination of silica and lime, and probably play no part in the formation of cement.

Magnesia though possessing marked hydraulic properties when igniled alone, yields no hydraulic products when heated with clay, and probably plays no part in the formation of cement, and it is incapable of replacing lime in cement mixtures.

The following analyses taken from the 1897 Mineral Industry will give an idea of the composition of clays used in portland cement, while following them are several Alabama occurence that could no doubt be used in cement manufacture.

FOREIGN CLAYS.

LOCALITY.	$Si O_2$	$Al_2 O_3$, $Fe_2 O$		$Ca CO$	$Ca O$	$Mg Co_3$	$Mg O$	Ign.
Glens Falls, N. Y.	55.27	28.15		....	5.84	....	2.25	8.50
Warner's, N. Y.	40.48	20.95		25.80	....	.99	....	11.90
Sandusdr, O	64.70	11.90	9.90	....	.90	....	.70	7.90
Bronson, Mich	62.10	20 09	7.81	....	.65	....	.96	12 08
Yankton, S. D	57.98	18.26	4.57	....	1.75	....	1.83	5.16
White Cliff, Ark	53.30	23.29	9.52	....	.36	....	1.49	6.12
" " "	65.12	19.05	7.66	....	.34	....	.31	
Medway, Eng.	63.66	16.16	6.74	....	.81	....	1.73	
Belgium, Beerse clay	65.50	18.55	6.01	....	.38	....	1.18	
Stettin, Germany	54.60	18.20	5.40	....	2.80	....	13.16	13.10

ALABAMA CLAYS.

LOCALITY.	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Alk.	Ign.
H. H. Cribb's, Tuscaloosa	63.35	21.30	2.72	.60	.86	....	7.35
Prattville	62.60	26.98	.72	.40	.36	.65	8.60
Birmingham. Graves' Mine.	57.80	25.00	4.00	2.10	.80	1.80	7.50
W. J. Beckwith, Colbert Co	58.20	29.86	2.21	.20	tr.	tr.	9.12
Pearce's Mill	52.95	35.10	.80	tr.	tr.	.93	11.40
Bedford, Lamar Co.	60.90	18.98	7.68	tr.	tr.	tr.	13.46

It is not necessary to give more than a few, additional cases being given in the preceding pages.

Limestone and marl or chalk is to be found at many localities within the State, so that both the materials used for Portland cement are available.

With the increasing use of this material, and the absence of any factories in the South, it would seem that Alabama offers an excellent field for the establishment and operation of several.

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GEOLOGICAL SURVEY OF ALABAMA

EUGENE ALLEN SMITH, STATE GEOLOGIST

BULLETIN No. 7

A PRELIMINARY REPORT

ON A PART OF THE

WATER POWERS OF ALABAMA

BY

B. M. HALL,

CONSULTING ENGINEER, U. S. GEOL. SURVEY,
FOR GEORGIA, FLORIDA, TENNESSEE AND MISSISSIPPI.

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1903.

11-10-1934

To His Excellency, William D. Jelks, Governor of Alabama:

Dear Sir: I have the honor to transmit herewith a preliminary report on the Water Powers of Alabama, by B. M. Hall, of the United States Geological Survey, Consulting Engineer, Hydrographic Division, for Alabama, Florida, Georgia, Tennessee, and Mississippi.

Our Alabama Geological Survey, in coöperation with the United States Geological Survey, has for a number of years been engaged in a systematic investigation of the Water Resources of the State. In this investigation we have naturally been less interested in that portion of the rainfall which passes back into the atmosphere by evaporation, than in those portions which, temporarily at least, become more or less incorporated with the materials forming our land surface, and which on that account may be considered as forming a part of our territory. And our investigation of this earth water, (to use a term to distinguish it from the atmospheric water), may appropriately be followed along two lines: It may be concerned, 1, with that part of the water which, collecting in rivulets, creeks and rivers, flows on towards the sea by open channels, *i. e.*, the "run-off"; or 2, it may take into account that part which soaks into the ground, and reaches the water courses or the sea only after an underground passage of greater or less duration, *i. e.*, the ground water or the "in-soak," if we may be allowed the use of such a word.

While the proportion of the rainfall which appears in the run-off of the streams varies between very wide limits, depending on the geological formations, the locality, etc., in Alabama on an average, about fifty per cent. of the rainfall is lost by evaporation and the remainder forms the run-off of the streams, and, curiously enough, only a small percentage of this run-off is supplied by the surface water alone, for most of it reaches the water courses by underground seepage.

In the course of this underground circulation the water may reach the surface from springs, from ordinary shallow and deep wells, and from artesian wells, and may be utilized for domestic and municipal water supply, and rarely, in Alabama at least, for irrigation and for power.

The present writer has had charge of this branch of the investigation, and his report on the Artesian and other underground Water Systems of the State is now in manuscript, and practically ready for the printers.

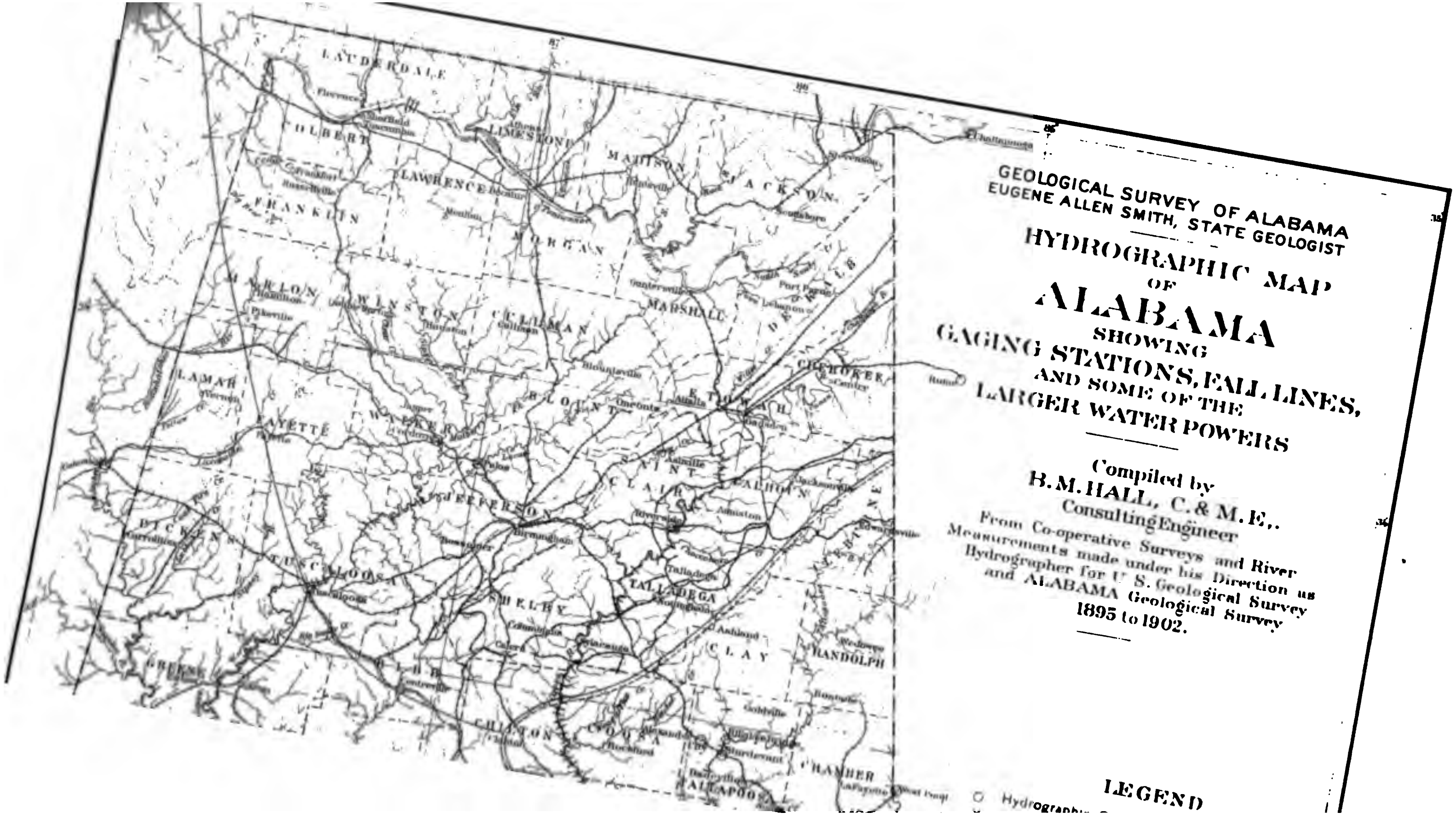
Most of the material for this report has been collected by the Alabama Geological Survey.

The run-off, on the other hand, is utilized for transportation, for domestic and municipal water supply, and for power, and this branch of the subject has been in charge of Mr. Hall, who has for some years been employed by the United States Geological Survey in collecting records of the gage heights, and in making surveys and discharge measurements of the principal streams of Alabama (and adjacent States), from which the values of these streams for the various purposes above enumerated may be closely estimated. In the collection of these data, the Alabama Geological Survey has contributed to the extent of paying the observers of the gage heights at seven stations along Alabama streams, but with this exception and apart from the map, the present Report has been prepared without cost to the State of Alabama. We are also indebted to the United States Geological Survey for most of the illustrations which appear in the body of the Report, and these cuts, as well as most of the data from which this Report has been compiled by Mr. Hall, have been published in the Annual Reports of the Director of the National Geological Survey.

While the present report deals with only one of the many uses to which the run-off of our streams may be put, viz., for the production of power, this is in many respects, especially in Alabama, the most important of these uses, for the great increase in the applications of electricity has of late turned attention to the utilization for its production, of water powers which have heretofore been allowed to run to waste, and there can be little doubt but that in comparatively short time, all the available water power of the State will be turned to account.

Very respectfully,
EUGENE A. SMITH,
State Geologist.

University of Alabama,
Dec. 1, 1902.



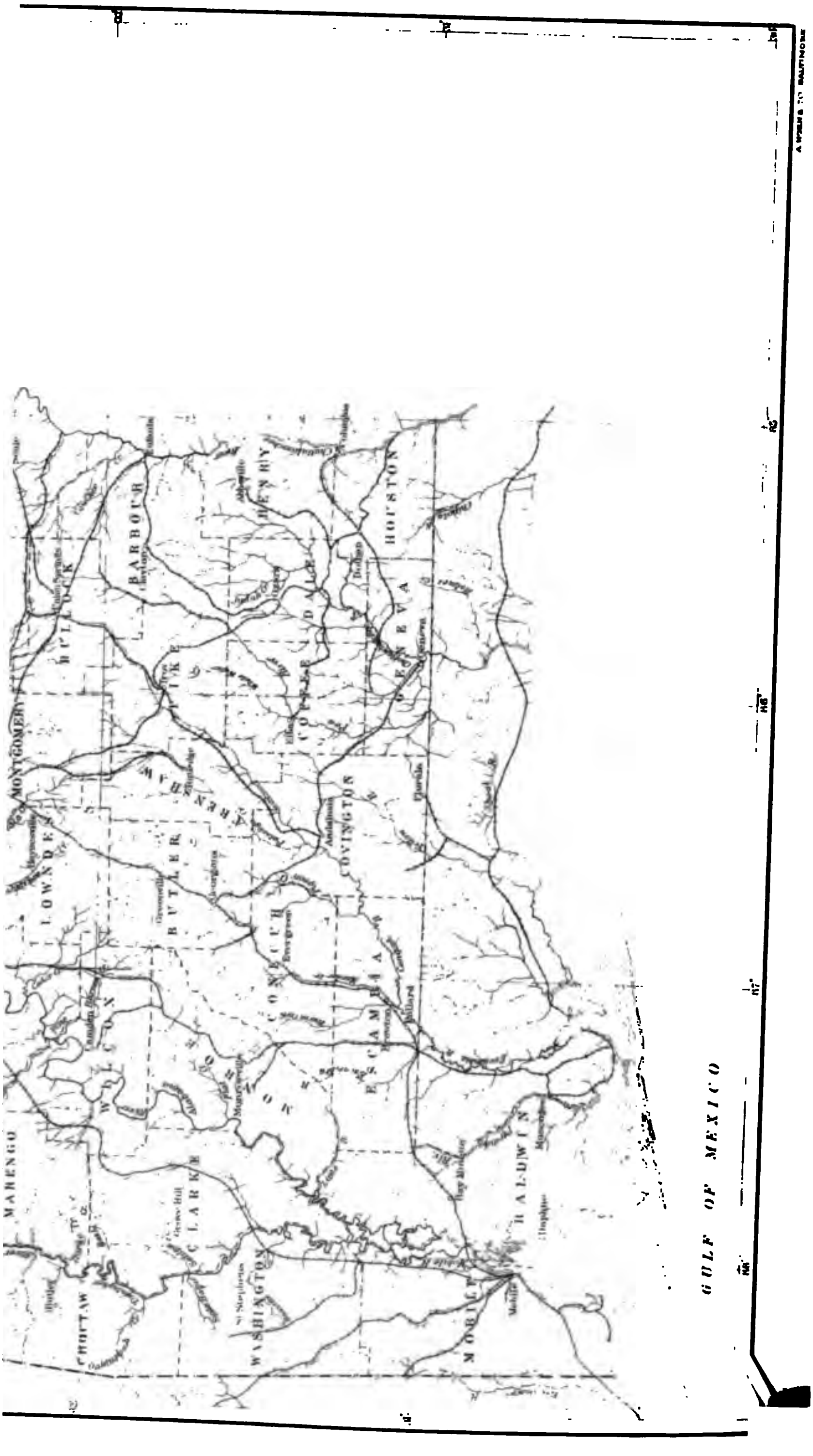
GEOLOGICAL SURVEY OF ALABAMA
EUGENE ALLEN SMITH, STATE GEOLOGIST

HYDROGRAPHIC MAP
OF
ALABAMA
SHOWING
GAGING STATIONS, FALL LINES, AND SOME OF THE LARGER WATER POWERS

Compiled by
B. M. HALL, C. & M. E.,
Consulting Engineer
From Co-operative Surveys and River
Measurements made under his Direction as
Hydrographer for U. S. Geological Survey
and ALABAMA Geological Survey
1895 to 1902.

LEGEND

○ Hydrographic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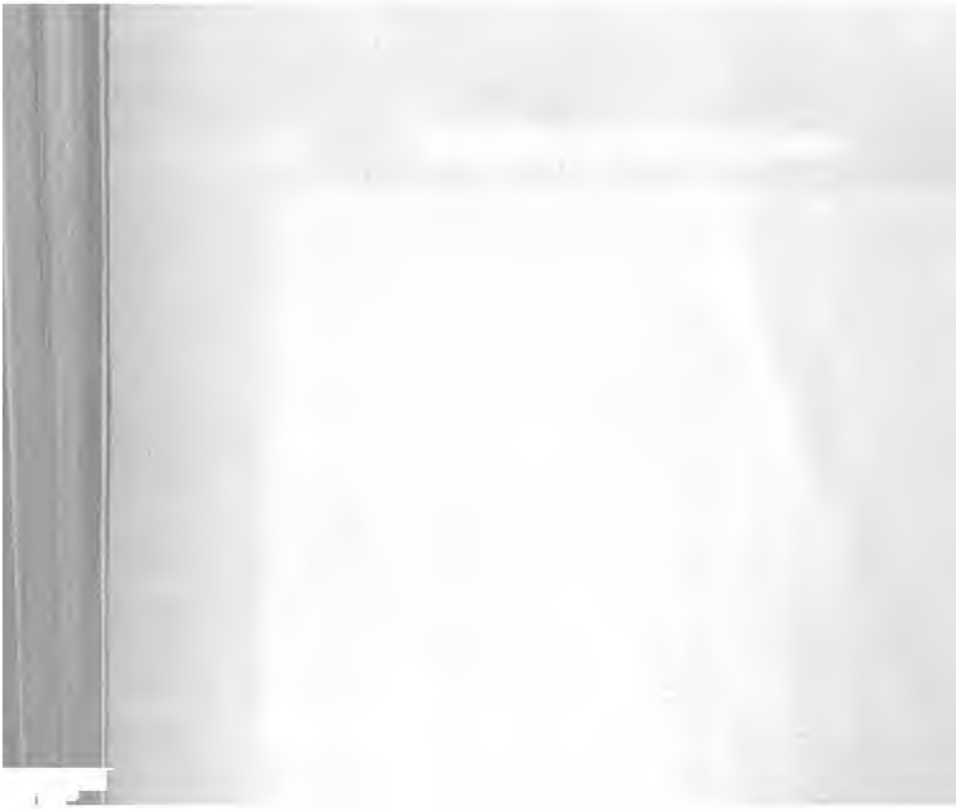

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PREFACE.

Very recently two large Water Powers have been developed on the Tallapoosa River, one of which is at Tallassee, Ala., and the other is three miles above Tallassee. These developments have awakened considerable interest in the undeveloped powers of the State, and this Bulletin undertakes to answer in a general way the numerous inquiries concerning them. Some of the largest of these unpublished powers are:

Power Site No. 3, on Tallapoosa River, at Double Bridges, about ten miles above Tallassee, where a head of 40 feet can be obtained. And other similar powers farther up the river.

Black and Sanford Shoal on Big Sandy Creek, near Dadeville, with 80 feet of fall.

Thirty-one locks on the Coosa River, capable of furnishing 1,300 to 4,500 horse power each, or an aggregate of 100,000 horse power during low season of an ordinary year like 1900.

Seven power sites on the Cahaba River capable of furnishing from 500 to 1,100 horse power each.

Squaw Shoals on the Black Warrior, with 43 feet of fall.

Also the following shoals on the Tennessee River:

Shoal:	Fall in feet.	Minimum H. P. dryest years.	Minimum H. P. average years.
Elk River Shoal	26	15,600	30,550
Big Muscle Shoal	85	51,000	99,375
Little Muscle Shoal	23	13,800	27,025
Colbert Shoal	21	12,600	24,675

These and other powers will be described more fully in Chapters II to VIII.

The water powers of Alabama are conveniently located for running cotton factories and other manufacturing plants, and also for generating electricity that can be transmitted to cities for power, light, etc. The larger powers are all close to water transportation, and are also on important railroads. These advantages will naturally make them more valuable than if they were otherwise located.

B. M. HALL.

Nov. 1, 1902.

CHAPTER I.

DRAINAGE BASINS, STREAMS, AND WATER POWERS.

DRAINAGE BASINS.

The five principal drainage basins of the State are:

First—The Apalachicola Basin, draining to the Chattahoochee and Apalachicola River, and entering the Gulf at Apalachicola, Fla.

Second—The Choctawhatchee Basin, draining to the Gulf through Choctawhatchee Bay.

Third—The Pensacola Basin, draining to Pensacola Bay and Perdido Bay, near Pensacola, Fla.

Fourth—The Mobile Basin, including the waters of Tallapoosa, Coosa, Cahaba, Alabama, Warrior, and Tombigbee Rivers, and draining into the Gulf at Mobile, Ala.

Fifth—The Tennessee Basin, draining into the Tennessee River, and thence through the Mississippi to the Gulf at New Orleans.

The water powers of the State are mainly in the Mobile and Tennessee Basins, which practically cover the entire State, except a small area in the southeast corner.

The area of crystalline rocks in Alabama is a triangle on the east side of the State, including Cleburne, Randolph, Chambers, Lee, Tallapoosa, Clay, Coosa, and parts of Elmore, Chilton, and Talladega counties. The "fall line," or escarpment dividing the Crystalline region from the Cretaceous formation of the Coastal plain on the southwest, runs from Columbus, Ga., crossing the Tallapoosa River at Tallassee, and the Coosa at Wetumpka. The northwestern boundary of the area of the Crystalline rocks which divides it from the Paleozoic formations, recrosses the Coosa River near Marble Valley postoffice, in Coosa county, and runs in a northeasterly direction towards Cedartown, Ga., crossing the Alabama line near Warner.

The line between the Paleozoic region and the Cretaceous formation runs from a point near Strasburgh, in Chilton county, in a northwesterly direction to Tuscaloosa, thence in a northerly direction to a point near Tuscumbia, and thence northwesterly to the Mississippi line.

The southwestern boundary of the Cretaceous passes from Fort Gaines, approximately, through Clayton, Troy, Snow Hill, and Livingston, in a northwesterly direction.

It may be said in a general way that the streams have their greatest falls in passing from an older to a younger geological formation. Tallassee Falls, on the Tallapoosa, and Wetumpka Falls, on the Coosa, are made in passing from the Crystalline to the Cretaceous. Those on Talladega Creek and other small streams in entering the Coosa Valley from the southeast in Talladega, Calhoun, and Cleburne counties, are from the Crystalline to the Paleozoic. The shoals above Centerville, on the Cahaba, above Tuscaloosa, on the Black Warrior, and near Tuscumbia, on the Tennessee River, are made in passing from the Paleozoic to the Cretaceous. As the Coosa River runs off of the Paleozoic on to the Crystalline near Talladega Springs, the shoals above this point reverse the general order by being made in passing from a younger to an older formation.

STREAMS AND WATER POWERS.

The following is a statement, according to water--shed, of the important streams and such data concerning them as can be compiled from the work of the Alabama Geological Survey, the United States Weather Bureau, and the United States Engineering Corps, combined with the hydrographic investigations of the United States Geological Survey under the direction of the compiler of this report. Aside from certain surveys made to obtain maps and profiles of Tallapoosa River and Big Sandy Creek, the work done by the Hydrographic Division of the United States Geological Survey in this State deals exclusively with the amount of water flowing in the streams, and is intended to give a safe basis for calculation of low water volumes at all seasons of the year, and for several consecutive years, in order to arrive at their value for water power, irrigation, municipal supply, mining, navigation, etc. In order to do this certain convenient stations have been established on important rivers. At each of these stations a gage rod is set to show the fluctuations of the streams; and a gage reader is employed to observe the height of the water every morning at the same hour, and to make a weekly report of the same to the Hydrographer-in-charge. As far as possible the river stations of the United States Weather Bureau and the United States Engineer Corps have been utilized for this purpose. From time to time the Hydrographer or one of his field assistants, visits the station and makes an accurate meter discharge measurement of the stream, noting the height of the water on the gage at the time the discharge measurement is made. After a number of such discharge measurements have been made at different gage-heights, a rating table is made from the data thus obtained, which gives the amount of water flowing in the stream, at that station, for any gage-height shown on the rod. Thus, by inspection of the table of daily gage-heights, the flow of the stream is shown for every day in the year, or years, covered by the observation of gage-height. At seasons of uniform low water, when the daily fluctuations of the rod are very slight for weeks at a time, discharge measurements are made of the stream at many points above and below the gage station in order to establish a relation between the discharge at these points and at the station. In like manner the principal tributaries are measured for the same purpose, where it is practicable to do so. In this way it is possible to arrive at a close estimate of the flow of all the streams of the water-shed, and make a rating of the gage for each that will represent its flow under average conditions, not including the floods caused by local rains. Such tributaries as have not been measured can be estimated by water-shed comparison with similar tributaries that have been measured.

In the following statement the actual gage-heights and discharge measurements are given in order to show the data upon which the conclusions are based. The regular gage stations that have been utilized are:

Station.	*Stream.*	*Observer.*	*Paid by.*
1—Milstead, Ala	Tallapoosa River	Seth Johnson	Ala. Geo. Sv.
2—Sturdevant, Ala	Tallapoosa River	B. F. Neighbors	Ala. Geo. Sv.
3—Dadeville, Ala	Big Sandy Creek	T. H. Finch	Ala. Geo. Sv.
4—Alexander City, Ala	Hillabee Creek	J. H. Chisolm	Ala. Geo. Sv.
5—Nottingham, Ala	Talladega Creek	R. M. McClatchy	Ala. Geo. Sv.
6—Riverside, Ala	Coosa River	J. W. Foster	Ala. Geo. Sv.
7—Cordova, Ala	Black Warrior R	A. B. Logan	Ala. Geo. Sv.
8—Montgomery, Ala	Alabama River	U. S. W. B	U. S. W. B.
9—Selma, Ala	Alabama River	U. S. W. B	U. S. W. B.
10—Tuscaloosa, Ala	Black Warrior R	W. S. Wyman, Jr	U. S. Eng. C.
11—Epes, Ala	Tombigbee River	J. C. Horton	A. G. S. Ry.
12—Rome, Ga	Coosa River	W. M. Towers	U. S. W. B.
13—Chattanooga, Tenn.	Tennessee River	U. S. W. B	U. S. W. B.

As the investigations in this State have been confined so far mainly to the Mobile and Tennessee basins, only the streams of these basins will be considered in the following discussion. It is to be remembered that from West Point, Ga., southwards, the line of Alabama is on the west bank of the Chattahoochee River, along the line where ordinary vegetation ceases to grow. This leaves all of the water power of the main stream on Georgia territory. There are many creeks flowing into the river from Alabama, some of which have considerable fall, as they come from a high plateau. Holland Creek, opposite Columbus, Ga., furnishes the Columbus water supply by gravity, having a fall of 117 feet in less than four miles. No doubt many of the others have as much fall, but as they have not been examined, a report on them cannot be made at present, but a recent reconnoissance along the Chattahoochee gives the following estimate of power obtained from some of them, 12 hours per day for each foot of fall, if the water is stored during the 12 idle hours:

Big Uchee Creek, Russell County........	7 H. P. per foot of fall.
Ihagee Creek, Russell County...........	2 H. P. per foot of fall.
Hatchechubbee Creek, Russell County...	7 H. P. per foot of fall.
Cowikee Creek, Barbour County..........	11 H. P. per foot of fall.
Yattayabba Creek, Henry County........	9 H. P. per foot of fall.
Omussee Creek, Henry county...........	7 H. P. per foot of fall.

EXPLANATION OF STATION RECORDS AND TABULAR STATEMENTS DEDUCED THEREFROM.

GAGE HEIGHTS.

The "Table of Gage Heights" is a record of the height of water on a gage rod, graded to feet and hundredths of a foot, set into the river vertically, and fastened permanently to a convenient tree or pier. The rod is read every day in the year, at the same time of day, which is about 8 o'clock in the morning. Inches are not used in these records, as the daily height of water on the gage is written in feet and decimals of a foot.

DISCHARGE MEASUREMENTS.

These records show the date, the gage height at time of measurement, and the amount of water in cubic feet per second, or "second-feet," that is found by the measurement to be flowing in the river. (Second-feet means the same as cubic feet per second.) If we imagine a small stream filling a rectangular flue 1 foot wide and 1 foot deep, we have a stream whose sectional area is 1 square foot. The volume of this stream will vary in proportion to the speed with which the water flows through the flume. If the water is moving at a velocity of 1 foot per second, the flow or volume of water is 1 cubic foot per second, and would fill a vessel 5 feet wide, 5 feet long, and 4 feet deep in just 100 seconds, as such a vessel would hold 100 cubic feet of water. If the water in the flume 1 foot wide and 1 foot deep flows with a velocity of 2 feet per second, the volume will be 2 cubic feet per second, or 2 second-feet, and so on for any other velocity. In the same way if the flume is 20 feet wide, and 5 feet deep, its sectional area will be 100 square feet, and if the average velocity is 3 feet per second, the volume will be 300 cubic feet per second, or 300 second-feet. In each of the discharge measurements here enumerated, a cross-section of the stream is measured, and velocities taken with an electric current-meter at many points of the cross-section. Instead of multiplying the entire cross-section by an average velocity, the area was divided up into a large number of small sections by soundings from 5 to 10 feet apart, and the area of each of the small sections multiplied by the velocity at the small section, thus giving the second-feet flowing in each small section. The sum of the discharges of all the small sections makes the total discharge of the stream.

RATING TABLE.

This is a table showing the discharges in second-feet (cubic feet per second) for all stages of water on the gage. Hence when the gage heights are known, the corresponding discharges can be taken from the rating table and written opposite each daily gage height, thus giving the flow in cubic feet per second on each day in the entire year.

ESTIMATED MONTHLY DISCHARGE, ETC.

This table gives in the first three columns, the maximum, minimum, and mean discharge for each month in cubic feet per second (second feet.) Column No. 4 gives the "total acre feet" flowing down the stream during each month. An "acre-foot" is the amount of water that would be necessary to cover one acre with a depth of one foot, which is 43,560 cubic feet. It furnishes a convenient unit for storage, where the water is to be used for irrigation. A cubic foot is practically 7.48 gallons, and is usually estimated at 7.5 gallons. An acre-foot is 43,560 cubic feet, or 320,851 gallons. One cubic foot per second flowing for 24 hours will cover an acre to a depth of 1.98 feet. It is therefore customary in round numbers to state that a cubic foot per second for a day of 24 hours is equivalent to 2 acre feet. Now, as one inch of rainfall per hour falling for 12 hours would cover one acre a foot deep, it is evident that rainfall at the rate of 1 inch per hour will produce a flow of 1 cubic foot per second, or 2 acre feet per 24 hours for each acre of watershed, no allowance being made for evaporation or percolation. It is also convenient to remember that 1,000,000 gallons in a reservoir are equal to a little more than 3 acre feet (3.069). In a general way it may be said that water stored in reservoirs is reckoned in acre-feet for irrigation, cubic feet for water power, and in millions of gallons for city water supply.

Columns 5 and 6 give the "run-off" from the drainage area. The run-off in inches and decimals of an inch is given, just as rainfall is given. For instance, a run-off of 2.23 inches from a given drainage area, means that enough water ran off during the month to have covered the entire drainage area or water-shed to a depth of 2.23 inches. This is convenient in estimating the proportion of the rain-fall on any drainage area that can be stored for irrigation, city water supply, or other purposes. The run-off in second-feet per square mile of drainage area, is obtained by dividing the mean discharge for the month by the number of square miles in the drainage area, and is useful in estimating the mean discharge of a tributary whose drainage area is known, and in comparing different drainage areas. The "run-off" is not a fixed percentage of the rainfall, but is that part of the rainfall which is not lost by evaporation into the air, or by percolation in subterranean outlets. Being a remainder and not a percentage, it necessarily forms a much larger proportion of a heavy annual rainfall than it does of a small annual rainfall. For instance, in the Crystalline region of Georgia or Alabama where the annual precipitation is 45 to 55 inches, the run-off from the water-sheds is equal to fully one-half of the rainfall, while in regions having a precipitation of only 10 to 20 inches annually, the run-off is frequently less than one-fifth of the rainfall. Again, the geological character of the water-shed makes a vast difference in the run-off, even where the annual rainfall is the same, and where practically the same conditions of climate, topography, forest area and cultivation exist. There will be a smaller run-off from the water-shed having permeable geological strata underneath it, into which a part of the rain water can percolate, and furnish the supply to artesian wells in the lower country under which the same strata run, without regard to surface topography. In a comparison of two such water-sheds, one in the crystalline region, and the other in a regularly stratified formation, the difference of run-off should form a basis for estimating the artesian supply obtainable from the latter as a fountain head.

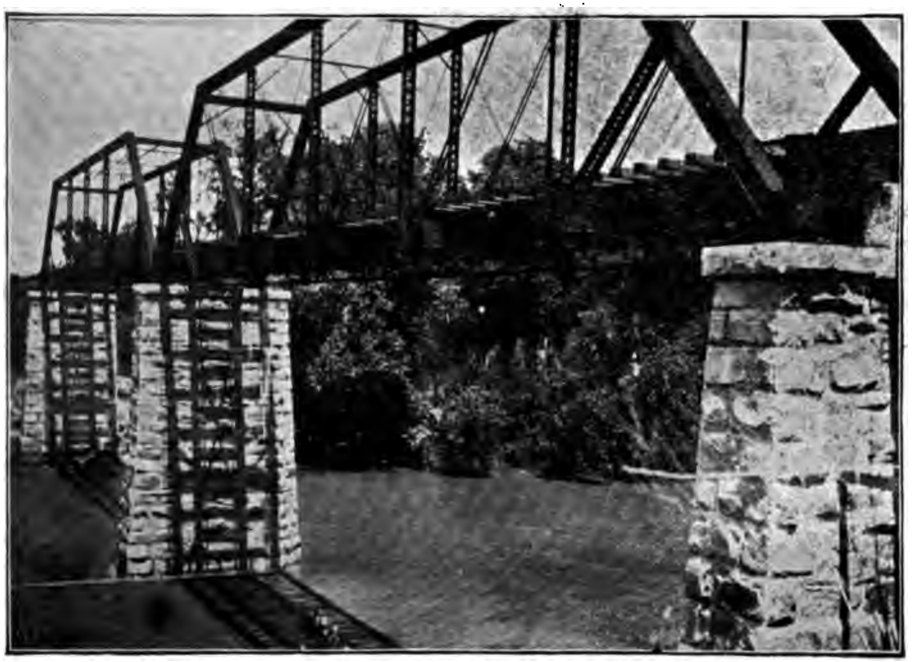

Plate A. Bridge at Milstead on Tallapoosa River.

CHAPTER II.

TALLAPOOSA RIVER AND TRIBUTARIES.

1. TALLAPOOSA RIVER AT MILSTEAD, ALABAMA.

Tallapoosa River rises in the west-central part of Georgia and flows in a southwesterly direction into Alabama, where it joins the Coosa, to form Alabama River, 6 miles above Montgomery, Alabama. Its upper tributaries drain an area between the Chattahoochee and Coosa basins. At Tallassee, Alabama, it crosses the southern fall line. The shoals at this place have a fall of 60 feet, forming an obstruction to navigation. The drainage area is largely wooded, with cultivated fields at short intervals. A gaging station was established at Milstead on August 7, 1897, at the bridge of the Tallassee & Montgomery Railway, about one-fourth of a mile from Milstead, Alabama. The bridge is of iron, two spans of about 155 feet each, with short wooden trestles at each end. The initial point of measurement is the end of the iron bridge, left bank, downstream side. The rod of wire gage is fastened to outside of guard rail on downstream side of bridge. The bench mark is top of second cross beam from left-bank pier, downstream end, and is 60.00 feet above datum. The channel is straight at the bridge, and bends above and below. The current is sluggish at low water and obstructed by center pier of bridge. The banks are high, but overflow at extreme high water for several hundred feet on each side. The bed is fairly constant, and all water is confined to the main channel by railroad embankments. The observer is Seth Johnson, a farmer and fruit grower, Milstead, Alabama. The plate A opposite shows this station.

The following discharge measurements were made during 1897 by Max Hall:

May 3, gage height, 6.20 feet; discharge, 7,333 second-feet.
July 15, gage height, 1.95 feet; discharge, 1,692 second-feet.
August 7, gage height, 2.42 feet; discharge, 2,292 second-feet.
September 4, gage height, 1.60 feet; discharge, 1,271 second-feet.
November 23, gage height, 1.20 feet; discharge, 677 second-feet.
December 16, gage height, 3.58 feet; discharge, 4,210 second-feet.

******Daily gage height, in feet, of Tallapoosa River at Milstead, Alabama, from August to December, 1897.*

Day.	Aug.	Sept.	Oct.	Nov.	Dec	Day.	Aug.	Sept.	Oct.	Nov.	Dec
1	......	1.70	0.80	0.90	1.50	17	1.90	1.10	0.80	1.20	2.80
2	......	1.80	.80	1.00	1.50	18	2.20	1.00	.90	1.20	2.40
3	......	1.60	.80	1.10	1.50	19	2.80	1.10	.90	1.20	2.10
4	......	1.60	.70	1.10	1.60	20	9.70	1.10	.90	1.10	2.00
5	......	1.60	.70	1.10	1.80	21	7.40	1.10	.80	1.20	1.90
6	......	1.40	.70	1.10	2.00	22	8.50	1.00	.80	1.10	2.00
7	2.45	1.40	.70	1.10	2.10	23	5.30	1.00	.90	1.10	2.40
8	1.90	1.30	.60	1.10	2.00	24	3.40	1.00	.90	1.20	2.40
9	1.70	1.20	.70	1.20	1.90	25	2.90	1.00	.80	1.20	2.40
10	1.50	1.20	.70	1.20	1.90	26	2.80	1.00	.90	1.20	2.80
11	1.50	1.10	.70	1.30	1.90	27	2.30	1.00	.90	1.20	2.60
12	2.70	1.10	.70	1.30	2.00	28	2.00	.90	.90	1.60	2.50
13	2.20	1.10	.70	1.30	1.90	29	1.80	.90	.90	1.50	2.30
14	2.00	1.10	.80	1.30	5.50	30	1.70	.80	.90	1.50	2.20
15	1.80	1.40	.80	1.20	4.70	31	1.70	......	.90	......	2.40
16	1.60	1.20	.80	1.20	3.60						

***See explanation, pages 11 to 14.**

Rating table for Tallapoosa River at Milstead, Alabama, for 1897.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet*	*Feet.*	*Second-feet*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.5	330	1.5	1,070	3.0	3,129	5.0	5,909
0.6	350	1.6	1,200	3.2	3,407	5.2	6,187
0.7	380	1.7	1,333	3.4	3,685	5.4	6,465
0.8	420	1.8	1,467	3.6	3,963	5.6	6,743
0.9	470	1.9	1,600	3.8	4,241	5.8	7,021
1.0	530	2.0	1,733	4.0	4,519	6.0	7,299
1.1	620	2.2	2,007	4.2	4,797	7.0	8,689
1.2	720	2.4	2,285	4.4	5,075	8.0	10,079
1.3	830	2.6	2,573	4.6	5,353	9.0	11,469
1.4	950	2.8	2,851	4.8	5,631		

NOTE—This table applied to the foregoing "Daily gage heights" gives the cubic feet per second flowing in the river on each date for which the gage height is given.

The following discharge measurements were made during 1898 by Max Hall and others:

Jan. 19—Gage height, 2.13 feet; discharge, 1,889 second-feet.
Feb. 19—Gage height, 2.20 feet; discharge, 2,045 secod-feet.
March 18—Gage height, 2.56 feet; discharge, 2,646 second-feet.
April 26—Gage height, 5.83 feet; discharge, 6,648 second-feet.
May 17—Gage height, 1.55 feet; discharge, 1,059 second-feet.
June 22—Gage height, 3.05 feet; discharge, 3,421 second-feet.
July 7—Gage height, 1.62 feet; discharge, 1,262 second-feet.
Aug. 5—Gage height, 13.67 feet; discharge, 15,295 second-feet.
Sept. 3—Gage height, 2.76 feet; discharge, 3,010 second-feet.
Nov. 29—Gage height, 5.16 feet; discharge, 5,477 second-feet.

Daily gage height, in feet, of Tallapoosa River at Milstead, Alabama, for 1898.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec
1	2.90	2.30	1.90	4.80	2.60	1.10	1.50	3.60	4.30	1.30	2.30	4.90
2	1.90	2.20	1.80	3.90	[illegible]	1.10	1.30	2.90	3.20	1.30	2.20	4.40
3	1.80	2.10	1.90	3.10	2.20	1.10	1.20	2.80	2.70	1.40	2.20	7.70
4	1.70	2.00	2.40	3.00	2.10	1.10	1.10	11.50	2.70	16.00	2.10	10.00
5	1.70	2.00	2.90	17.00	2.00	1.10	1.20	14.00	4.00	32.00	2.10	8.60
6	1.80	2.00	2.80	18.80	2.00	1.10	1.30	8.90	4.60	23.50	2.20	6.80
7	1.80	2.00	2.50	12.10	1.90	1.00	1.70	10.10	6.00	16.40	2.70	5.60
8	1.80	2.00	2.30	7.10	1.90	.90	2.90	8.50	5.60	22.80	4.20	4.80
9	1.90	2.00	2.20	5.20	1.80	.90	4.90	7.90	4.50	14.00	2.80	4.60
10	1.90	1.90	2.00	4.00	1.80	.90	3.60	5.30	3.50	7.90	3.00	6.70
11	1.90	1.90	2.00	3.40	1.70	.80	4.40	17.30	2.90	5.90	7.10	6.10
12	2.40	1.90	2.00	3.10	1.70	.90	2.00	22.60	2.60	4.90	5.10	5.50
13	2.40	1.90	1.90	3.00	1.70	[illegible]	1.70	10.10	2.50	3.80	5.00	5.00
14	2.60	1.90	1.90	2.90	1.60	1.20	2.70	7.70	2.40	3.40	5.90	4.40
15	2.40	1.80	2.70	2.80	1.60	1.10	3.50	6.10	2.20	3.00	5.50	4.00
16	2.40	1.80	2.60	2.60	1.60	1.20	5.10	4.20	2.00	2.70	5.40	3.80
17	2.40	1.80	2.50	2.40	1.60	2.10	2.40	3.40	1.80	2.60	6.20	3.60
18	2.30	1.90	2.60	2.40	1.60	1.80	2.80	2.80	1.70	4.40	6.10	3.40
19	2.20	2.20	2.50	2.20	1.50	1.40	3.05	2.60	1.60	5.00	14.40	4.30
20	2.20	2.30	2.40	2.40	1.50	1.40	2.30	2.80	1.60	4.40	12.20	7.60
21	3.10	2.30	2.20	2.80	1.40	1.40	1.90	2.50	1.50	3.70	10.00	7.00
22	3.10	2.10	2.00	2.70	1.40	3.00	1.60	2.30	1.50	3.30	8.00	5.20
23	3.00	2.00	1.90	2.80	1.30	2.40	1.60	2.20	1.50	3.10	10.00	4.40
24	2.90	2.00	1.90	14.50	1.30	2.20	1.50	2.00	1.60	2.70	8.80	6.40
25	2.60	1.90	1.80	11.60	1.20	2.10	1.50	2.10	1.80	2.60	7.90	6.00
26	2.90	1.80	1.80	5.90	1.20	1.80	2.50	8.10	2.00	2.50	5.30	4.60
27	3.60	1.90	1.80	4.30	1.20	1.50	2.60	10.20	1.80	2.40	4.60	4.20
28	3.90	1.90	1.70	3.30	1.30	1.80	4.10	8.40	1.60	2.40	4.10	3.90
29	3.10	......	2.20	2.95	1.20	2.70	2.80	7.00	1.50	2.40	4.90	3.80
30	2.65	......	4.20	2.80	1.20	1.90	2.90	5.20	1.50	2.40	5.40	3.70
31	2.40	......	5.30	......	1.10	......	3.80	5.10	......	2.30	......	4.00

Rating table for Tallapoosa River at Milstead, Alabama, for 1898.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second Ft.*	*Feet.*	*Second Ft.*	*Feet.*	*Second Ft.*
0.8	540	2.4	2,380	8.0	8,820
0.9	655	2.5	2,495	8.5	9,395
1.0	770	2.6	2,610	9.0	9,970
1.1	885	2.7	2,725	9.5	10,545
1.2	1,000	2.8	2,840	10.0	11,120
1.3	1,115	2.9	2,955	10.5	11,695
1.4	1,230	3.0	3,070	11.0	12,270
1.5	1,345	3.5	3,645	11.5	12,845
1.6	1,460	4.0	4,220	12.0	13,420
1.7	1,575	4.5	4,795	12.5	13,995
1.8	1,690	5.0	5,370	13.0	14,570
1.9	1,805	5.5	5,945	13.5	15,145
2.0	1,920	6.0	6,520	14.0	15,720
2.1	2,035	6.5	7,095	14.5	16,295
2.2	2,150	7.0	7,670	15.0	16,870
2.3	2,265	7.5	8,245		

NOTE.—This table applied to the foregoing "Daily gage heights" gives the cubic feet per second flowing in the river on each date for which the gage height is given.

The following discharge measurements were made during 1899 by Max Hall:

April 17—Gage height, 6.34 feet; discharge, 7,444 second-feet.
April 18—Gage height, 5.63 feet; discharge, 6,853 second-feet.
May 17—Gage height, 2.80 feet; discharge, 3,000 second-feet.
June 26—Gage height, 2.05 feet; discharge, 1,847 second-feet.
September 9—Gage height, 1.36 feet; discharge, 1,016 second-feet.
November 8—Gage height, 1.25 feet; discharge, 972 second-feet.
December 18—Gage height, 2.66 feet; discharge, 2,844 second-feet.

Daily gage height, in feet, of Tallapoosa River, at Milstead, Alabama, for 1899.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec
1.........	5.00	17.00	27.00	18.00	4.30	2.40	2.80	3.00	2.40	0.70	1.50	2.40
2.........	4.60	11.60	19.00	12.20	4.00	2.90	2.30	2.70	2.30	.70	1.40	2.50
3.........	3.90	24.50	13.50	6.50	3.90	2.40	1.90	3.10	2.10	.80	1.40	2.60
4.........	3.90	20.00	9.60	6.40	3.80	2.40	1.80	3.10	2.00	.90	1.30	2.60
5.........	3.90	12.90	14.20	8.50	3.70	2.30	1.60	2.50	1.80	1.00	1.30	2.90
6.........	3.80	11.90	13.20	9.70	3.60	2.20	1.50	2.30	1.60	1.40	1.20	2.20
7.........	7.40	17.50	10.10	10.30	3.50	2.10	1.50	2.20	1.60	1.40	1.20	2.00
8.........	8.00	27.00	8.60	13.00	3.60	2.00	2.00	2.00	1.40	1.30	1.20	1.90
9.........	7.10	19.00	7.70	13.00	3.50	1.90	2.20	1.80	1.40	1.30	1.20	1.80
10.........	6.40	13.80	7.20	11.20	3.40	1.70	2.00	1.60	1.30	1.30	1.20	1.90
11.........	18.50	10.00	6.80	8.40	3.30	1.90	1.80	1.50	1.20	1.40	1.30	2.00
12.........	16.80	8.30	6.60	7.00	3.20	2.00	1.70	1.70	1.20	1.40	1.30	15.20
13.........	13.00	7.40	6.50	6.50	3.10	2.00	1.50	1.60	1.20	1.30	1.30	13.20
14.........	11.60	7.00	6.40	6.20	3.10	2.70	1.40	1.60	1.10	1.30	1.30	8.20
15.........	9.40	6.10	7.20	6.00	3.00	2.70	1.30	1.50	1.00	1.20	1.30	5.00
16.........	7.80	10.40	12.20	7.10	2.90	2.60	1.30	4.00	1.00	1.10	1.30	3.70
17.........	12.70	11.50	11.00	6.60	2.80	2.10	1.20	3.90	1.00	1.20	1.60	3.00
18.........	10.00	10.60	10.20	5.60	2.70	1.90	1.10	2.20	1.00	1.10	1.50	2.60
19.........	8.00	9.30	14.80	5.50	2.60	1.80	1.60	1.90	1.10	1.20	1.50	2.50
20.........	6.50	8.30	13.90	5.40	2.50	1.80	1.40	1.70	1.00	1.30	1.50	2.70
21.........	5.70	8.30	10.40	5.20	2.60	1.70	8.40	1.50	.90	1.40	1.40	2.70
22.........	5.30	8.40	8.30	5.00	2.70	1.50	16.75	1.60	1.00	1.50	1.40	2.70
23.........	5.10	7.60	8.10	4.90	2.60	1.50	14.00	2.00	1.00	1.60	1.60	2.60
24.........	5.20	6.90	12.70	6.00	3.30	1.50	16.95	2.60	.90	1.80	1.80	9.30
25.........	5.20	6.40	8.70	10.00	4.60	1.50	7.90	1.90	.90	1.50	2.20	9.40
26.........	5.10	6.30	7.30	7.50	3.30	2.00	6.70	1.80	.90	1.40	4.60	7.20
27.........	4.80	25.00	6.90	6.60	2.80	2.50	6.80	3.70	.90	1.30	6.20	5.00
28.........	4.70	37.00	6.80	5.80	2.60	2.50	8.40	2.80	.80	1.20	4.80	4.00
29.........	5.10	......	9.00	4.90	2.50	2.20	10.10	2.10	.80	1.50	3.60	3.50
30.........	5.20	......	8.90	4.60	2.60	2.70	5.40	1.90	.80	1.50	2.80	3.10
31.........	6.50	......	13.85	......	2.50	.. ..	4.40	2.30	......	1.60	......	2.90

Rating table for Tallapoosa River at Milstead, Alabama, for 1899.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second Ft.*	*Feet.*	*Second Feet.*	*Feet.*	*Second Ft.*
0.7	320	6.5	7,437	17.5	20,977
0.8	430	7.0	8,052	18.0	21,582
0.9	550	7.5	8,667	18.5	22,179
1.0	672	8.0	9,282	19.0	22,812
1.1	795	8.5	9,897	19.5	23,427
1.2	918	9.0	10,512	20.0	24,042
1.3	1,041	9.5	11,127	20.5	24,657
1.4	1,164	10.0	11,742	21.0	25,272
1.5	1,287	10.5	12,357	21.5	25,887
1.6	1,410	11.0	12,972	22.0	26,502
1.7	1,533	11.5	13,587	22.5	27,117
1.8	1,656	12.0	14,202	23.0	27,732
1.9	1,779	12.5	14,817	23.5	28,347
2.0	1,902	13.0	15,432	24.0	28,962
2.5	2,517	13.5	16,047	24.5	29,577
3.0	3,132	14.0	16,662	25.0	30,192
3.5	3,747	14.5	17,277	25.5	30,807
4.0	4,362	15.0	17,892	26.0	31,422
4.5	4,977	15.5	18,507	26.5	32,037
5.0	5,592	16.0	19,122	27.0	32,652
5.5	6,207	16.5	19,737	27.5	33,287
6.0	6,822	17.0	20,352	27.9	33,779

NOTE—This table applied to the foregoing "Daily gage heights" gives the cubic feet per second flowing in the river on each date for which the gage height is given.

During the year 1900 the following discharge measurements were made by Max Hall:

Feb. 23—Gage height. 9.20 feet; discharge, 9,956 second-feet.
March 5—Gage height, 6.70 feet; discharge, 7,088 second-feet.
Dec. 3—Gage height, 2.95 feet; discharge, 3,031 second-feet.

Daily gage height, in feet, of Tallapoosa River near Milstead, Alabama, for 1900.

Day.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec
1........	2.70	2.50	13.20	5.50	6.30	2.60	9.00	6.50	2.70	1.80	2.50	3.30
2........	2.60	2.40	13.10	5.30	5.90	2.70	9.10	4.50	8.00	1.60	3.30	3.30
3........	2.40	2.30	10.70	5.00	5.40	3.00	10.60	3.50	8.10	1.50	6.10	3.30
4........	2.30	4.50	8.00	5.30	4.90	3.50	7.10	2.80	4.40	1.80	6.50	3.50
5........	2.30	4.20	6.80	4.80	4.70	3.30	8.00	2.70	3.00	3.30	7.10	3.90
6........	2.30	4.30	6.10	4.70	3.90	3.50	5.20	2.50	2.40	6.40	5.50	3.90
7........	2.20	4.40	5.60	4.60	3.80	3.30	4.40	2.30	2.20	3.40	4.10	3.80
8........	2.20	3.80	10.90	4.60	3.70	5.90	4.00	2.20	2.00	3.20	3.50	3.80
9........	2.20	5.20	13.80	4.50	3.60	9.70	3.50	2.10	1.80	2.60	3.00	3.10
10........	2.20	8.90	12.70	4.60	3.50	6.90	7.60	2.00	1.70	2.60	2.90	3.10
11........	2.60	19.00	10.00	5.50	3.30	5.60	5.50	1.90	1.70	3.00	2.70	2.80
12........	7.30	30.00	7.90	10.60	3.20	4.60	4.10	1.90	1.60	2.80	2.60	2.80
13........	6.00	43.25	6.60	11.50	3.10	5.30	4.70	1.80	1.50	3.40	2.60	2.80
14........	4.50	42.00	5.90	9.00	3.00	4.00	6.70	1.90	1.50	3.30	2.50	7.70
15........	4.00	31.90	5.40	6.60	2.90	3.80	6.00	2.20	14.00	3.30	2.50	9.10
16........	3.40	22.80	7.00	5.30	2.90	3.50	5.10	2.70	25.60	2.70	2.50	7.30
17........	3.00	13.50	7.20	4.70	2.80	4.50	3.80	3.10	18.00	2.70	2.50	5.20
18........	2.90	8.90	5.60	13.90	2.80	5.90	3.80	2.50	11.00	2.20	2.50	4.20
19........	3.70	7.00	5.40	17.00	2.80	5.70	3.60	4.00	5.30	2.10	2.50	4.00
20........	9.50	6.10	6.00	15.00	2.90	5.90	3.10	4.20	3.60	2.00	2.50	8.60
21........	7.50	6.50	11.40	16.90	2.80	5.90	3.00	2.50	3.00	1.90	2.50	17.00
22........	5.90	9.80	10.50	13.30	3.00	5.50	2.80	2.20	2.50	2.00	4.00	13.50
23........	4.60	9.50	7.60	10.30	3.10	5.40	2.70	2.00	2.30	4.80	4.00	10.40
24........	3.90	8.90	15.50	13.20	3.40	20.00	2.60	2.30	2.20	12.10	3.90	11.30
25........	3.50	8.40	15.20	12.50	3.50	25.04	2.50	3.30	2.00	10.50	3.50	8.70
26........	3.10	8.00	16.00	9.40	5.00	20.00	2.50	3.40	2.00	9.00	10.50	6.60
27........	3.00	7.00	13.70	7.50	4.50	16.00	2.80	3.60	2.00	6.00	8.80	5.60
28........	2.80	6.00	11.20	6.40	3.20	18.00	2.90	2.70	2.00	4.20	6.70	5.00
29........	2.70	......	8.70	6.20	2.70	13.80	3.20	2.60	2.00	3.20	4.50	4.60
30........	2.60	......	7.10	6.10	3.00	9.00	8.10	2.10	1.90	2.90	3.70	4.30
31........	2.50	......	6.20	......	2.50	......	10.60	3.20	......	2.70	......	11.00

The following measurements were made by Max Hall and James R. Hall during 1901:

Feb. 12—Gage height, 10.70 feet; discharge, 11,759 second-feet.
March 13—Gage height, 5.55 feet; discharge, 5,644 second-feet.
October 29—Gage height, 1.70 feet; discharge, 1,583 second-feet.

Daily gage height of Tallapoosa River at Milstead, Ala., for 1901.

Day.	Jan.	Feb.	Mar.	Apr	May.	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1.......	14.30	7.40	5.30	26.00	5.00	8.40	5.10	2.10	4.00	2.20	1.70	2.00
2.......	15.50	7.20	5.20	22.00	4.80	8.00	4.20	2.20	3.50	2.90	1.70	2.00
3.......	14.50	7.50	5.10	23.00	4.70	9.7	4.30	2.30	2.90	6.10	1.70	1.95
4.......	11.00	24.07	5.00	18.00	4.60	10.90	4.00	2.20	2.70	6.40	1.80	2.20
5.......	9.80	26.00	4.90	14.20	4.40	8.00	3.30	2.10	2.40	5.10	1.95	2.40
6.......	8.70	18.30	4.70	10.80	4.30	[illegible]	3.60	2.10	2.20	4.00	1.95	2.40
7.......	7.40	12.60	4.50	9.60	4.20	12.10	4.00	2.60	2.10	3.20	2.00	2.30
8.......	6.10	10.50	4.40	7.20	4.20	10.10	4.80	2.60	2.00	2.50	1.90	2.20
9.......	5.30	13.10	4.40	6.80	4.10	6.30	4.70	2.30	2.00	2.10	1.90	2.20
10.......	5.00	14.00	4.70	6.20	3.90	5.90	3.70	2.30	1.90	2.00	2.00	2.20
11.......	6.00	12.60	7.70	5.80	3.80	4.50	2.90	2.10	1.90	1.90	1.90	2.30
12.......	24.20	10.90	6.00	5.60	3.80	4.10	2.60	2.30	1.80	1.90	1.80	2.50
13.......	30.50	9.80	5.50	6.10	3.80	4.20	2.60	2.90	1.80	1.90	1.80	2.40
14.......	22.00	8.20	6.00	8.80	4.50	5.[illegible]	2.10	2.50	2.80	2.00	1.75	2.60
15.......	18.00	7.70	5.50	10.70	4.30	7.30	2.20	2.10	4.20	2.10	1.75	6.00
16.......	11.50	6.90	5.10	8.70	4.00	5.70	2.30	3.20	3.10	2.10	1.80	13.40
17.......	12.20	6.60	4.50	7.70	3.60	6.00	5.30	8.90	3.00	2.00	1.80	9.00
18.......	12.10	6.50	4.10	11.00	3.80	[illegible]	4.80	8.00	5.60	1.90	1.80	6.00
19.......	9.70	6.30	4.00	23.00	3.50	4.40	4.30	6.60	9.10	1.90	1.90	3.90
20.......	8.00	6.20	6.00	22.00	5.50	4.00	3.50	5.90	7.10	1.80	2.10	3.60
21.......	7.10	5.90	7.90	13.40	10.50	3.[illegible]	3.30	9.60	5.00	1.80	2.20	3.40
22.......	6.80	5.80	6.30	10.70	16.20	3.30	3.10	7.20	3.80	1.70	2.20	3.20
23.......	6.40	5.70	6.20	8.90	14.20	3.30	2.80	20.75	2.70	1.70	2.30	3.10
24.......	6.20	6.00	10.10	7.60	12.00	3.90	3.50	21.00	2.30	1.70	2.20	3.10
25.......	7.00	6.10	8.90	6.90	9.00	9.10	2.40	9.40	2.10	1.70	2.20	3.00
26.......	6.80	6.10	10.20	6.50	10.00	3.10	2.20	5.90	2.10	1.60	2.10	2.90
27.......	6.70	6.00	14.30	6.10	8.40	2.90	2.50	4.20	2.00	1.70	2.30	2.95
28.......	6.70	5.50	17.50	5.80	6.40	2.80	2.50	5.90	2.10	1.70	2.20	3.05
29.......	6.60	......	15.00	5.50	6.00	2.60	2.30	8.70	2.30	1.70	2.10	38.00
30.......	6.80	......	9.90	5.20	5.10	2.60	2.20	7.70	2.50	1.70	2.00	47.00
31.......	7.00	......	31.50	......	4.80	......	2.20	4.70	......	1.70	......	39.00

Rating table for Tallapoosa River at Milstead, Ala., for 1900 and 1901.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height	Discharge.
Feet.	*Second Ft.*	*Feet.*	*Second Ft*	*Feet.*	*Second Ft.*
1.5	1,337	4.1	3,262	18.0	19,900
1.6	1,450	4.2	4,375	19.0	21,025
1.7	1,562	4.3	4,487	20.0	22,150
1.8	1,675	4.4	4,600	21.0	23,275
1.9	1,787	4.5	4,712	22.0	24,400
2.0	1,900	4.6	4,825	23.0	25,525
2.1	2,012	4.7	4,937	24.0	26,650
2.2	2,125	4.8	5,050	25.0	27,775
2.3	2,237	4.9	5,162	26.0	28,900
2.4	2,350	5.0	5,275	27.0	30,025
2.5	2,462	5.5	5,837	28.0	31,150
2.6	2,575	6.0	6,400	29.0	32,275
2.7	2,687	6.5	6,962	30.0	33,400
2.8	2,800	7.0	7,525	31.0	34,525
2.9	2,912	7.5	8,087	32.0	35,650
3.0	3,025	8.0	8,650	33.0	36,775
3.1	3,137	8.5	9,212	34.0	37,900
3.2	3,250	9.0	9,775	35.0	39,025
3.3	3,362	10.0	10,900	36.0	41,150
3.4	3,475	11.0	12,025	37.0	41,275
3.5	3,587	12.0	13,150	38.0	42,400
3.6	3,700	13.0	14,275	39.0	43,525
3.7	3,812	14.0	15,400	40.0	44,650
3.8	3,925	15.0	16,525	41.0	45,775
3.9	4,037	16.0	17,650	42.0	46,900
4.0	4,150	17.0	18,775	43.0	48,025

NOTE—This table applied to the foregoing "Daily gage heights" gives the cubic feet per second flowing in the river on each date for which the gage height is given.

Estimated monthly discharge of Tallapoosa River at* ***Milstead, Ala.*

[Drainage area, 3.840 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Depth in inches.	Second-feet per square mile.
1897.						
August, 7-31	12,440	1,070	3,173	157,340	0.77	0.83
September	1,467	420	742	44,155	0.21	0.19
October	470	380	424	26,070	0.12	0.11
November	1,200	470	729	43,379	0.21	0.19
December	6,604	1,070	2,214	136,135	0.67	0.58
1898.						
January	4,105	1,575	2,426	149,170	0.72	0.63
February	2,265	1,690	1,912	106,187	0.52	0.50
March	5,715	1,575	2,313	142,222	0.69	0.60
April	21,240	2,150	5,748	342,029	1.67	1.50
May	2,610	885	1,493	91,802	0.45	0.39
June	3,070	540	1,314	78,188	0.38	0.34
July	5,485	885	2,493	153,290	0.75	0.65
August	25,610	1,920	7,418	456,118	2.22	1.93
September	6,520	1,345	2,637	156,912	0.77	0.69
October	36,420	1,115	7,280	447,633	2.19	1.90
November	16,180	2,035	6,049	359,940	1.76	1.58
December	11,120	3,530	5,741	353,003	1.73	1.50
1899.						
January	22,197	4,116	8,417	517,541	2.53	2.19
February	44,952	6,945	15,688	871,267	4.26	4.09
March	32,652	7,314	12,399	762,385	3.72	3.23
April	21,582	5,100	9,016	536,489	2.62	2.35
May	4,731	2,517	3,351	206,045	1.00	0.87
June	2,999	1,287	2,040	121,388	0.59	0.53
July	20,290	795	4,985	306,516	1.50	1.30
August	4,362	1,287	2,222	136,625	0.67	0.58
September	2,394	430	984	58,552	0.29	0.26
October	1,656	320	1,014	62,348	0.30	0.26
November	7,068	918	1,787	106,334	0.53	0.47
December	18,138	1,656	4,728	290,713	1.42	1.23
1900.						
January	10,335	2,125	3,728	229,226	1.12	0.97
February	48,305	2,237	12,950	719,206	3.50	3.37
March	17,650	5,723	10,208	627,665	3.07	2.66
April	18,775	4,712	9,016	536,489	2.62	2.35
May	6,736	2,462	3,718	228,611	1.12	0.97
June	27,831	2,575	8,317	494,896	2.42	2.17
July	11,572	2,462	5,405	332,340	1.63	1.41
August	6,960	1,675	2,814	173,026	0.84	0.73
September	28,447	1,337	4,975	296,033	1.45	1.30
October	13,262	1,337	3,787	232,854	1.14	0.99
November	11,460	2,462	4,224	251,345	1.23	1.10
December	18,775	2,800	6,475	398,132	1.95	1.69
The year	48,305	1,337	6,301	4,519,823	22.09	1.64

*See explanation page 13.

Estimated monthly discharge of Tallapoosa River near Milstead, Ala.

[Drainage area, 3,840 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Depth in inches.	Second-feet per square mile.
1901.					
January	33,962	5,275	11,476	3.45	2.99
February	28,900	5,837	10,440	2.83	2.72
March	35,087	4,150	8,374	2.52	2.18
April	28,900	5,499	12,020	3.49	3.13
May	17,875	3,587	6,440	1.94	1.68
June	13,262	2,775	5,976	1.74	1.56
July	5,387	2,012	3,398	1.01	.88
August	23,275	2,012	5,904	1.78	1.54
September	9,887	1,675	3,137	.91	.82
October	6,849	1,562	2,364	.71	.62
November	2,237	1,562	1,855	.54	.48
December	*70,000	1,843	8,282	2.49	2.16
The year	*70,000	1,562	6,639	23.41	1.73

*Approximate.

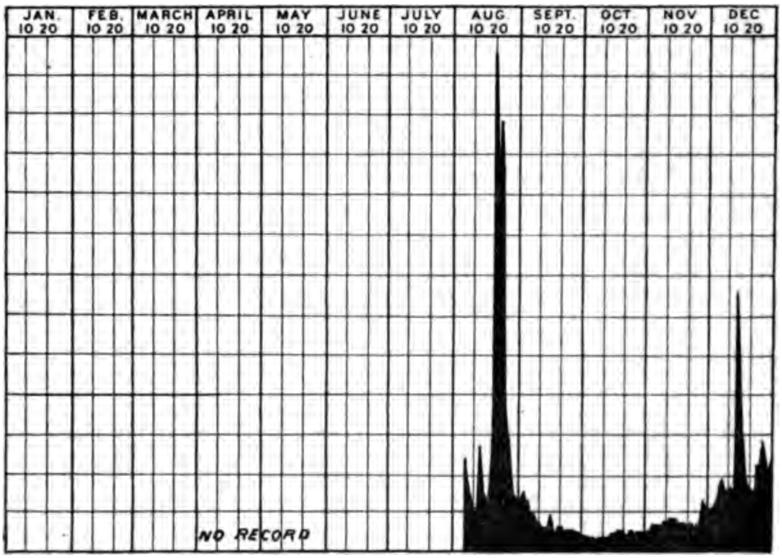

Fig. 1—Discharge of Tallapoosa River at Milstead, Ala., 1897.

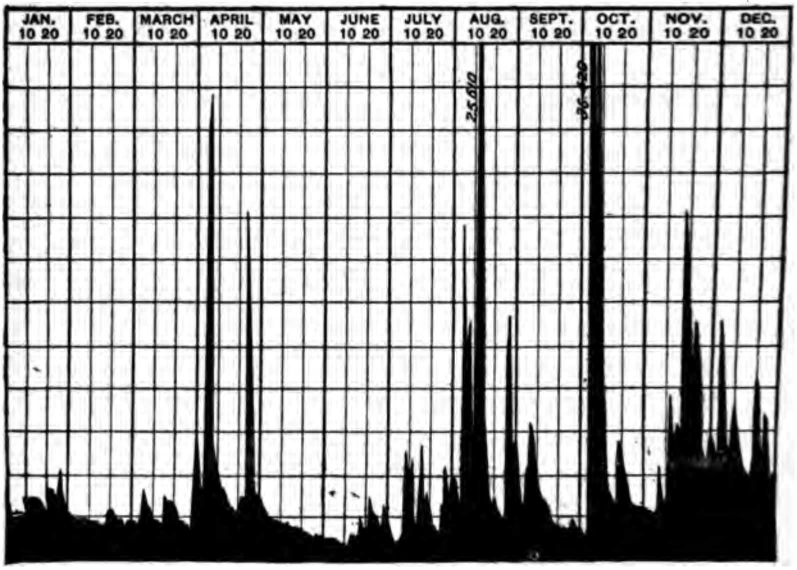

Fig. 2—Discharge of Tallapoosa River at Milstead, Ala., 1898.

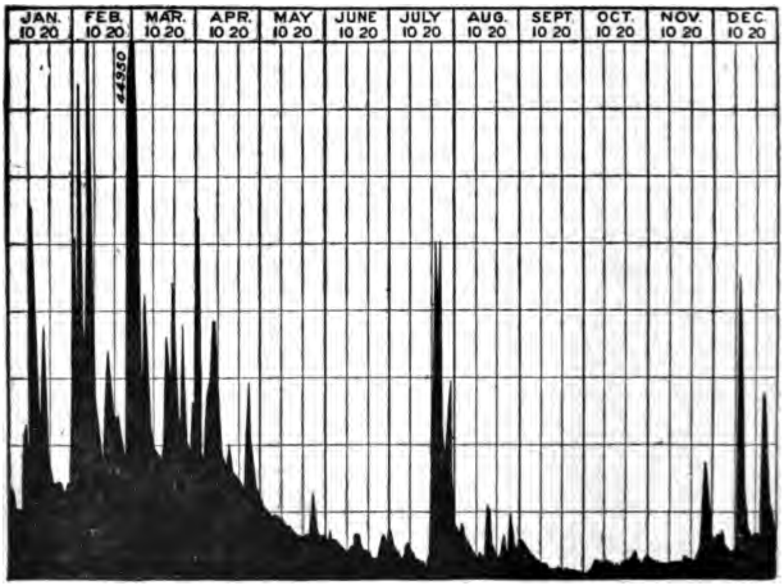

Fig. 3—Discharge of Tallapoosa River at Milstead, Ala., 1899.

The amount of water delivered from the drainage basin as measured at the points named below has been computed in terms of depth in inches. The normals given are the monthly averages for times during which measurements or computations were had. The figures for the yearly normal are the sums of these monthly averages.

Depth of run-off in inches from the drainage basin of Tallapoosa River at Milstead, Ala.

Day.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Normal ...	1.96	2.78	2.50	2.60	1.13	1.28	1.22	1.38	.86	1.09	1.02	1.90	19.70
1898	.72	.52	.69	1.67	.45	.38	.75	2.22	.77	2.19	1.76	1.73	13.85
1899	2.53	4.26	3.72	2.62	1.00	.59	1.50	.67	.29	.30	.53	1.42	19.43
1900	1.12	3.50	3.07	2.62	1.12	2.42	1.63	.84	1.45	1.14	1.23	1.95	22.09
1901	3.45	2.83	2.52	3.49	1.94	1.74	1.01	1.78	.91	.71	.54	2.49	23.41

Minimum monthly discharge of Tallapoosa River at Milstead, Ala., with corresponding net horsepower per foot of fall on a water wheel realizing 80 per cent. of the theoretical power.

	1899			1900			1901		
	Minimum cubic feet per second.	Minimum net H. P. per foot of fall.	No. of days duration of minimum.	Minimum cubic feet per second.	Minimum net H. P. per foot of fall.	No. of days duration of minimum.	Minimum cubic feet per second.	Minimum net H. P. per foot of fall.	No. of days duration of minimum.
January ...	4,116	374	1	2,125	193	4	5,275	480	1
February .	6,945	631	1	2,237	203	1	5,837	531	1
March	7,314	665	1	5,725	520	2	4,150	377	1
April	5,100	464	1	4,712	428	1	5,500	500	1
May	2,517	229	3	2,462	224	1	3,587	326	2
June	1,287	117	4	2,575	234	1	2,575	234	2
July	795	72	1	2,462	224	2	2,012	183	1
August ...	1,287	117	3	1,675	152	1	2,012	183	5
September	430	39	3	1,337	122	2	1,675	152	2
October ...	320	29	2	1,337	122	1	1,562	142	10
November .	918	83	5	2,462	244	9	1,562	142	3
December .	1,656	151	1	2,800	255	3	1,843	168	1

Note—To find the minimum net horse power available at a shoal on this stream, near this station, for any month, multiply the total fall of the shoal by the "net H. P. per foot of fall" in this table for that month.

2. TALLAPOOSA RIVER NEAR SUSANNA. ALABAMA.

This station was established July 27, 1900, by J. R. Hall. It is located at the mouth of Blue Creek, which is 10 feet above the east landing of McCarty's ferry, 13 miles southwest of Dadeville, and 3 miles from Susanna, the nearest postoffice. The rod is graduated to feet and tenths; it is 18 feet long, and is nailed vertically to a tree overhanging the water on the south side of the creek at the junction of the creek and the river. The gage is referred to a bench mark on a white hickory tree about 40 feet from the rod on the south bank of the creek, and is 376.67 feet above tide water. Discharge measurements are made from a boat held in place by a wire stretched across the river, upon which the distances from the initial point are tagged. The section is an exceptionally good one, depth and current being almost uniform the entire width of the stream. The observer is T. A. Walls, a farmer who lives 1 mile from the station. During 1900 and 1901 the following discharge measurements were made by James R. Hall:

1900:
July 27—Gage height, 1.80 feet; discharge, 2,309 second-feet.
August 9—Gage height, 1.55 feet; discharge, 1,900 second-feet.
September 28—Gage height, 1.50 feet; discharge, 1,809 second-feet.
November 24—Gage height, 2.40 feet; discharge, 3,629 second-feet.
1901:
July 9—Gage height, 2.80 feet; discharge, 5,628 second-feet.
Feb. 27.—Gage height, 2.90 feet; discharge, 5,135 second-feet.

NOTE—The gage was washed away, and this station was discontinued on March 30th, 1901.

Daily gage height, in feet, of Tallapoosa River, near Susanna, Ala., for 1900.

Day.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July	Aug.	Sept.	Oct.	Nov.	Dec.
1......	......	5.80	2.40	1.40	1.80	2.00	17......	......	1.95	8.40	2.35	1.75	2.60
2......	......	4.00	3.80	1.40	1.70	2.00	18......	......	1.95	4.80	2.30	1.75	2.50
3......	......	2.00	4.80	1.40	1.70	2.10	19......	......	1.80	3.00	2.20	1.80	2.40
4......	......	1.80	4.20	1.35	1.65	2.20	20......	......	1.75	2.50	2.10	1.85	4.50
5......	......	1.80	2.25	1.30	1.65	2.30	21......	......	1.70	1.80	1.90	1.85	5.80
6......	......	2.10	1.50	2.80	1.65	2.50	22......	......	1.70	1.80	1.70	1.90	4.50
7......	......	2.20	1.45	3.00	1.60	2.40	23......	......	1.90	1.80	3.90	2.40	4.00
8......	......	1.70	1.45	2.50	1.60	2.40	24......	......	2.00	1.70	6.00	2.40	4.00
9......	......	1.55	1.40	1.85	1.60	2.40	25......	......	2.05	1.60	5.00	3.00	3.70
10......	......	1.50	1.35	1.80	1.60	2.30	26......	......	2.50	1.50	4.30	4.90	3.20
11......	......	1.40	1.35	1.75	1.60	2.10	27......	1.80	2.15	1.50	4.10	4.20	2.80
12......	......	1.40	1.35	1.70	1.55	2.00	28......	1.90	2.00	1.50	2.30	3.90	2.70
13......	......	1.40	1.35	1.90	1.55	1.90	29......	1.80	1.90	1.45	2.20	3.00	2.60
14......	......	1.40	1.30	2.40	1.60	3.90	30......	4.00	1.80	1.45	1.90	2.80	2.70
15......	......	1.40	1.35	2.45	1.60	3.90	31......	.680	2.25	.....	1.85	.....	2.90
16......	......	1.90	11.70	2.40	1.60	2.80							

Daily gage height of Tallapoosa River at Susanna, Ala., for 1901.

Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.
1........	6.0	3.40	2.70	12........	13.5	4.00	3.10	23........	3.0	2.80	2.70
2........	6.0	3.45	2.60	13........	11.6	3.50	2.90	24........	3.1	2.90	3.30
3........	5.1	3.30	2.65	14........	8.0	3.04	2.60	25........	3.4	3.00	3.40
4........	4.5	11.50	2.70	15........	6.1	3.30	2.50	26........	3.1	3.00	3.60
5........	3.9	9.50	2.65	16........	4.5	3.20	2.40	27........	3.2	2.90	7.40
6........	3.5	6.50	2.60	17........	5.0	3.10	2.40	28........	3.1	2.80	6.90
7........	3.2	4.40	2.50	18........	4.5	3.10	2.40	29........	3.0	......	6.10
8........	3.0	4.30	2.40	19........	3.9	3.05	2.45	30........	3.2	......	4.10
9........	2.9	4.80	2.50	20........	3.4	3.00	3.00	31........	3.3	......	.....
10........	2.8	4.90	2.70	21........	3.2	2.90	8.40				
11........	3.4	4.50	3.30	22........	3.1	2.85	2.90				

Rating table for Tallapoosa River, at Susanna, Ala., 1900 and *1901.*

Gage Height.	Discharge.	Gage Height.	Discharge.
1.0	.....	4.0	11,030
1.2	.....	4.2	11,930
1.4	1,680	4.4	12,830
1.6	1,960	4.6	13,730
1.8	2,320	4.8	14,630
2.0	2,740	5.0	15,530
2.2	3,230	5.5	17,780
2.4	3,850	6.0	20,030
2.6	4,730	6.5	22,280
2.8	5,630	7.0	24,530
3.0	6,530	8.0	29,030
3.2	7,430	9.0	33,530
3.4	8,330	10.0	38,030
3.6	9,230	11.0	42,530
3.8	10,130	11.7	45,680

NOTE—This table applied to the foregoing "Daily gage heights" gives the cubic feet per second flowing in the river on each date for which the gage height is given.

Estimated monthly discharge of Tallapoosa River, near Susanna, Alabama.

[Drainage area, 2,610 square miles.]

Month	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Total in acre-feet.	Depth in inches.	Second feet per square mile.
1900.						
July 27 to 31.........	....	....	8,364	....	......	......
August	19,130	1,680	3,258	200,327	1.44	1.25
September	45,680	1,570	6,083	361,964	2.60	2.33
October	20,030	1,570	4,776	293,665	2.11	1.83
November	15,080	1,885	3,676	218,737	1.57	1.41
December	19,130	2,520	6,288	386,634	2.78	2.41

Estimated monthly discharge of Tallapoosa River, near Susanna, Alabama.
[Drainage area, 2,610 square miles.]

Month.	Discharge in second-feet			Run-off.	
	Maximum.	Minimum.	Mean.	Depth in inches.	Second-feet per square mile.
1901.					
January	53,780	5,630	13,265	5.86	5.08
February	44,780	5,630	11,303	4.51	4.33
March	26,330	3,850	7,546	3.31	2.89

Minimum monthly discharge of Tallapoosa River at Susanna, Ala., with corresponding net horsepower per foot of fall on a water wheel realizing 80 per cent. of the theoretical power.
[Drainage area, 2,610 square miles.]

	1900				1901		
	Minimum cubic feet per second.	Minimum net H. P. per foot of fall.	No. of days duration of minimum.		Minimum cubic feet per second.	Minimum net H. P. per foot of fall.	No. of days duration of minimum.
July	2,320	211	2	January	5,630	512	1
August	1,680	153	5	February	5,630	512	2
September	1,570	143	1	March	3,850	350	4
October	1,570	143	1				
November	1,885	171	2				
December	2,520	229	1				

NOTE—To find the minimum net horse power available at a shoal on this stream, near this station, for any month, multiply the total fall of the shoal by the "net H. P. per foot of fall" in this table for that month.

3. TALLAPOOSA RIVER, NEAR STURDEVANT, ALABAMA.

This station was established July 19, 1900, by J. R. Hall. It is located at the bridge, Columbus & Western Division of the Central of Georgia Railroad, a fourth of a mile west of Sturdevant. The gage rod is 20 feet high, and is graduated to feet and tenths. It is in two sections, and is fastened vertically, the shorter section to a post at the edge of the waer on the east bank, about 20 feet below the bridge, and the longer section to the first stone pier from the east bank. It is so set that when the water rises above the short section it is on the long section, and the readings are made as from one continuous rod. The initial point of sounding is the east end of the bridge. The section is broken by three piers and by some large rocks below the bridge. The gage is referred to a bench mark consisting of a nail in the southwest corner of pier No. 2, east side of the river, 455.70 feet above tide water, and 14.20 feet above the zero of the gage. The observer is B. F. Neighbors, farmer and postmaster at Sturdevant, who lives a fourth of a mile from the station. During 1900 the following discharge measurements were made by James R. Hall:

July 20—Gage height, 2.85 feet; discharge, 2,603 second-feet.
August 13—Gage height, 1.95 feet; discharge, 1,887 second-feet.

Daily gage height, in feet, of Tallapoosa River near Sturdevant, Ala. for 1900.

Day.	July	Aug	Sept	Oct	Nov	Dec	Day.	July	Aug	Sept	Oct	Nov	Dec
1	.....	4.30	3.40	1.80	2.50	2.90	17	.....	3.00	7.00	2.60	2.30	3.20
2	.....	3.40	6.10	1.70	3.40	2.80	18	.....	2.80	5.00	2.20	2.20	3.10
3	.....	2.80	4.20	1.60	4.70	2.70	19	2.95	4.00	3.80	2.10	2.20	3.00
4	.....	2.50	2.90	1.60	3.60	3.00	20	2.80	2.90	3.00	2.00	2.20	5.20
5	.....	2.40	2.50	3.30	3.30	3.20	21	3.05	2.40	2.70	1.90	2.50	6.80
6	.....	2.35	2.20	3.00	3.20	3.30	22	2.75	2.30	2.50	2.10	3.20	5.30
7	.....	2.25	2.00	3.00	2.90	3.20	23	2.65	2.40	2.40	5.00	3.50	4.90
8	.....	2.20	1.90	2.90	2.70	3.00	24	2.55	2.70	2.30	7.30	3.20	5.60
9	.....	2.10	1.80	3.10	2.60	2.80	25	2.65	2.50	2.20	6.40	4.80	4.70
10	.....	2.00	1.70	3.20	2.50	2.70	26	2.60	2.80	2.10	5.40	5.90	4.20
11	.....	1.95	1.60	3.30	2.40	2.60	27	2.50	2.60	2.00	4.20	5.40	3.90
12	.....	1.90	1.60	3.40	2.40	2.60	28	2.70	2.50	2.00	3.60	3.40	3.60
13	.....	2.00	1.60	3.50	2.40	2.70	29	6.50	2.40	2.00	2.90	3.20	3.40
14	.....	2.10	1.80	3.50	2.30	4.70	30	7.60	2.30	1.90	2.70	3.10	3.50
15	.....	2.60	8.80	3.00	2.30	3.00	31	5.00	2.80	.....	2.60	.....	7.50
16	.....	3.40	12.00	2.60	2.30	3.70							

During the year 1901 James R. Hall made one measurement, as follows:

March 8—Gage height, 3.40 feet; discharge, 3,774 second-feet.

During the year 1902 the following discharge measurements have been made at Sturdevant by W. E. Hall:

July 11—Gage height, 1.85 feet; discharge, 1,440 second-feet.
September 17—Gage height, 0.80 feet; discharge, 658 second-feet.
October 9—Gage height, 1.08 feet; discharge, 858 second-feet.
November 12—Gage height, 1 34 feet; discharge, 1,000 second-feet.

Daily gage height of Tallapoosa River at Sturdevant, Ala., for 1901.

Day.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec
1........	7.0	4.6	3.8	7.4	3.8	5.5	4.0	3.1	3.2	2.4	1.6	1.7
2........	6.8	4.5	3.8	6.8	3.7	5.5	3.5	2.8	2.9	4.5	1.6	1.7
3........	6.0	5.8	3.7	8.3	3.7	5.3	3.2	2.5	2.7	6.0	1.6	2.1
4........	5.4	12.9	3.7	7.4	3.6	5.2	3.0	2.3	2.6	3.4	1.6	2.2
5........	4.9	9.4	3.6	5.7	3.5	4.8	2.9	2.3	2.4	2.7	1.7	2.3
6........	5.2	7.7	3.6	5.0	3.5	4.6	2.8	2.2	2.3	2.3	1.8	2.2
7........	5.1	6.5	3.5	4.7	3.4	5.6	4.3	2.1	2.2	2.1	1.8	2.1
8........	4.0	5.4	3.4	4.4	3.4	4.9	4.0	2.4	2.1	2.0	1.8	2.1
9........	4.0	5.7	3.4	4.2	3.3	3.8	3.4	2.2	2.0	2.0	1.8	2.2
10........	4.1	5.4	3.9	4.0	3.3	3.6	3.0	2.0	2.0	2.0	1.8	2.2
11........	6.0	5.2	4.3	3.9	3.3	3.4	2.6	2.2	2.0	1.9	1.7	2.3
12........	14.1	5.1	4.0	3.9	3.2	3.3	2.3	2.4	2.0	1.9	1.7	2.2
13........	11.0	4.8	3.8	4.1	3.2	3.2	2.2	2.3	2.0	2.1	1.7	2.1
14........	9.2	4.6	3.6	6.0	3.4	4.9	2.1	2.2	4.0	2.1	1.8	3.0
15........	6.1	4.4	3.4	6.4	3.3	4.4	2.1	2.0	3.4	2.0	1.8	7.8
16........	5.3	4.3	3.3	5.3	4.2	4.[illegible]	2.0	5.3	2.8	2.0	1.8	5.9
17........	5.7	4.2	3.3	4.7	3.1	3.8	2.2	7.2	3.6	1.9	1.8	4.1
18........	5.3	4.2	3.2	4.4	3.0	3.6	3.8	5.9	7.0	1.9	1.8	3.5
19........	4.0	4.1	3.2	8.5	3.0	3.3	3.6	5.3	5.2	1.8	2.0	3.0
20........	4.4	4.1	3.6	9.0	3.3	3.1	3.2	6.6	4.3	1.8	2.2	2.8
21........	4.3	4.0	4.3	6.7	6.1	3.0	3.0	5.8	3.4	1.7	2.2	2.6
22........	4.2	4.0	3.9	5.2	7.6	2.9	2.8	5.6	3.0	1.7	2.3	2.5
23........	4.1	4.0	3.7	4.8	7.0	2.8	2.4	11.7	2.4	1.7	2.2	2.5
24........	4.2	4.0	4.5	4.6	6.5	2.7	2.2	8.3	2.3	1.7	2.2	3.0
25........	4.3	4.0	4.3	4.4	5.3	2.7	2.1	5.2	2.2	1.7	2.1	2.8
26........	4.2	4.0	5.4	4.3	6.8	2.6	2.1	4.0	2.1	1.7	2.1	2.7
27........	4.1	3.9	8.7	4.2	4.5	2.6	2.1	3.3	2.0	1.6	2.0	2.6
28........	4.3	3.9	8.2	4.1	4.4	2.5	2.1	4.4	2.0	1.6	1.9	2.8
29........	4.5	......	7.5	4.0	4.3	2.5	2.0	5.2	2.2	1.6	1.8	15.7
30........	4.5	......	5.0	3.9	4.2	5.2	2.1	4.3	2.3	1.6	1.8	17.2
31........	4.6	......	8.9	......	4.0	......	2.8	3.5	......	1.6	......	12.0

4. SURVEY OF TALLAPOOSA RIVER IN ALABAMA.

This survey of a part of Tallapoosa River in Alabama was made in June and July, 1900, under supervision of B. M. Hall, resident Hydrographer, by Field Engineer James R. Hall, levelman and topographer.

The survey began at the Hydrographic Station on the Tallapoosa River, at Milstead, Ala., and ran up the river 64 miles to head of shoal above Griffin's Ferry. The elevations are sea-level elevations.

DESCRIPTION OF RIVER.

The entire river above Milstead runs on granite bed-rock, and has numerous bluffs along its banks, forming excellent sites for dams.

There are two large developed water powers on the river: The Tallassee Falls plant, and the Montgomery Power Company's plant, both of which are near the lower end of the survey. (*See Plates B and C, opposite.*)

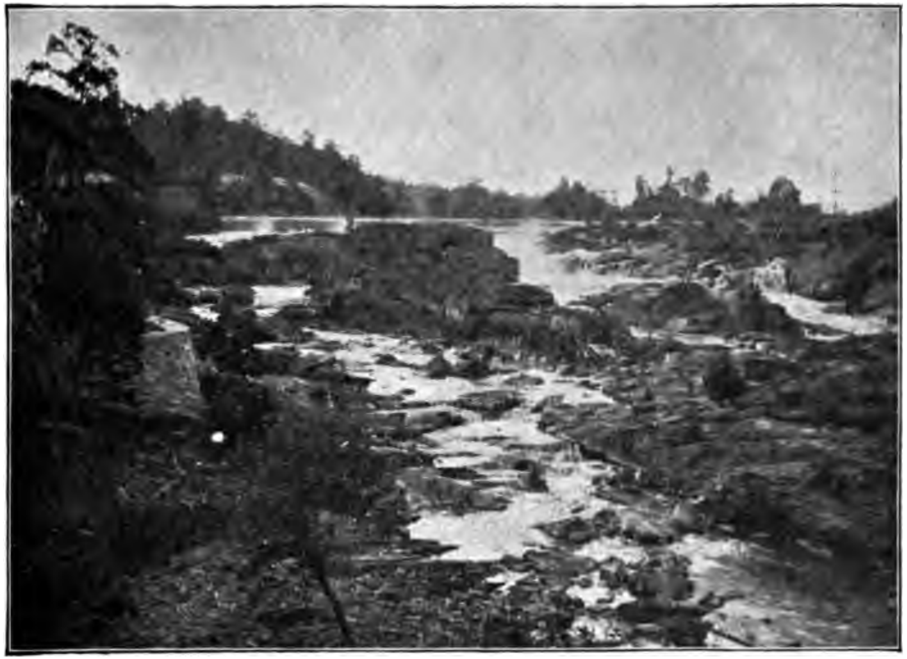

Plate B. Tallassee Falls on Tallapoosa River.

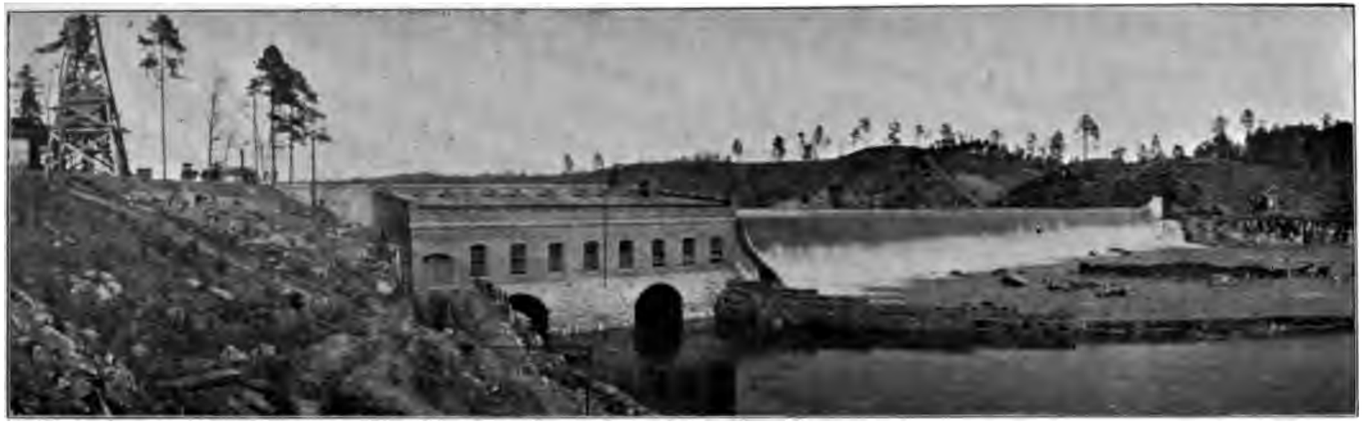

Plate C. Power House and Dam, Montgomery Power Company, on Tallapoosa River, near Tallassee, Ala.

The Tallassee Falls dam and canal, which are six miles above Milstead, utilize a fall of 64 feet, with the whole river. This power and its large cotton manufacturing plant recently completed, is described in the Twentieth Annual Report, U. S. Geological Survey, Part IV, Pages 192-193. This power was capable of realizing 8,900 net H. P. without storage during low water of October, 1901. A break which occurred in the dam on December 29, 1901, has decreased the present available head, but does not stop the machinery.

The Montgomery Power Company dam has a 40-foot dam, nine and a half miles above Milstead. It backs the water six and a half miles up the river, and forms an immense storage basin. This being almost completed in December, 1901, was partly washed out by a great flood December 29, 1901. The water wheels, dynamos, pole line and wiring to Montgomery are all installed, and ready for work as soon as the dam is repaired. The distance to Montgomery is about 27 miles.

With river at stage of lowest water during October, 1901, this plant will develop at the wheels 5.572 net H. P. from the run of the river without drawing on the storage.

The equalizing storage of this dam will add fully 25 per cent. to this power and to the power at Tallassee for continuous running without materially lowering the head at either plant.

The following list of distances and elevations of water and bench marks shows the fall of the river from point to point. The total fall in 56 of the 64 miles surveyed is 364 feet.

*Elevations and bench marks along Tallapoosa River from **Milstead**, Ala., to Griffin Shoals.*

Distance from Milstead.	Description or location.	Bench mark elevation above sea level.	Elevation above sea level.
6.0	River surface of tailwater at Tallassee mills		206.3
6.2	Water above crest of Tallasee dam		269.9
8.5	Upper end of Tallassee Pond		269.9
9.5	River below Montgomery Power Company's dam		295.25
9.5	Crest of Montgomery Power Company's dam		335.25
15.7	Upper end of Montgomery Power Co.'s Pond		335.25
16.5	Water at Double Bridge Ferry		351.46
16.8	Water at mouth of Wind Creek		352.45
16.8	Bench mark' No. 7, bunch of mulberry trees at the mouth of Wind Creek	357.85	
17.8	Bench mark, No. 22, crooked willow on small branch at north end of Taylor's field	363.30	
17.8	Water at bench mark No. 22		356.18
18.5	Water opposite mouth of Kowaliga Creek		357.16
18.75	Bench mark' No. 33, mulberry 100 feet above old Baker field	371.73	
18.75	Water at bench mark No. 33		359.75
19.4	Bench mark No. 42, willow at Garnetts Ford	364.60	
19.4	Water at Garnetts Ford		360.55
19.7	Bench mark No. 46, pine at mouth of High Falls Branch	373.98	
19.7	Water at "blue hole" at mouth of High Falls Branch		362.40
20.1	Water at "blue hole" at foot of Long Branch shoals		362.40
21.0	Bench mark No. 62, mulberry, 300 yards above mouth of Long Branch	382.45	
21.0	Water at bench mark No. 62, top of Long branch shoals		367.23
21.3	Bench mark No. 70, white hickory at McCarty's Ferry, mouth of Blue Creek	376.6	
21.3	Water at McCarty's Ferry, mouth of Blue Creek		367.80
23.0	Top of shoal opposite mouth of Peru Branch		372.55
23.8	Water at mouth of Gold Mine Branch		375.17
23.8	Bench mark No. 100, mulberry at mouth of Gold Mine Branch	386.00	
24.4	Bench mark No. 110, water oak at Robinson's Ferry	404.40	
24.4	Water at Robinson's Ferry		380.20
25.6	Water at top of Upper Robinson Shoals		389.10
25.6	Bench mark No. 124, small sycamore at mouth of small branch	395.10	
27.7	Water at mouth of small branch in Pace's field		390.90
28.7	Bench mark No. 140, watr oak at foot of Hardy Shoals, in Pace's field	414.30	
29.5	Bench mark No. 150, dead stump 100 feet below the mouth of Big Sandy Creek	398.08	
29.5	Water at mouth of Big Sandy Creek		
30.0	Bench mark No. 165, big red oak at Young's Ferry	413.50	
30.0	Water at Young's Ferry		394.00
31.0	Water at Cherokee Bluff		394.60
31.2	Bench mark No. 175, big walnut 200 yards above Monowa Creek	416.75	
34.0	Bench mark No. 180, 16-inch pine tree at third bar of Seago Shoals	424.72	
34.0	Water at third bar of Seago Shoals, opposite bench mark No. 180		399.92
35.8	Bench mark No. 190, large white oak at east landing at Walkers Ferry	436.90	
35.8	Water at Walkers Ferry		429.65
37.0	Bench mark No. 210, leaning white oak at mouth of small branch at upper end of Upshaw place	438.60	
37.4	Water at bench mark No. 210		432.00
37.6	Water at top of fish trap		436.47
38.3	Bench mark No. 215, 16-inch white oak on small branch at upper end of Locke's old field	448.90	

Distance from Milstead.	Description or location.	Bench mark elevation above sea level.	Elevation above sea level.
38.3	Water at bench mark, No. 215		438.00
39.3	Water under Central railroad bridge at Sturdevant, Alabama		444.25
39.3	Bench mark on top of rail over first pier of the east end of Central Railroad bridge	505.90	
41.2	Bench mark No. 210. large water oak at east landing of Dennis Ferry	457.15	
41.2	Water at Dennis Ferry		445.85
42.2	Water at mouth of branch on left bank of river		448.20
45.3	Water 600 feet below mouth of Hillabee Creek		472.60
48.3	Bench mark No. 310, water oak at east landing of Welch's Ferry	504.15	
48.3	Water at Welch's Ferry		492.30
50.0	Bench mark No. 330, beech 150 feet above mouth of Freeman's Branch	526.62	
50.0	Water 150 feet above mouth of Freeman's Branch		521.04
52.0	Water at Whaleys Ferry		529.48
52.0	Bench mark No. 340, birch at Whaleys Ferry	539.38	
55.4	Bench mark No. 350, 10-inch birch at Millers Ferry	552.16	
55.4	Water at Millers Ferry		544.00
60.8	Water at Griffins Ferry		557.10
60.8	Bench mark No. 380, double ash tree on left bank at Griffins Ferry	564.76	
62.0	Bench mark No. 390, 12-inch birch at head of Griffins Shoals	573.87	
62.0	Water at head of Griffins Shoals		570.30

Surveys have been made for a large dam, 35 or 40 feet in height, at or near Double Bridge Ferry, to back the water beyond Robinson's Ferry, a distance of about 8 miles up the river. There is an excellent site for a dam, and the project is entirely feasible. The horse power in proportion to head would be the same as that available at the Montgomery Power Company's dam.

From the mouth of Big Sandy Creek to a point one mile above Griffin's Ferry, a distance of 32 miles, the fall of the Tallapoosa River is 176.5 feet. Nearly all of this fall can be utilized for power by developments similar to those which have been made, and proposed below. A study of the profile and of the above table of distances and elevations will give the distribution of the fall, showing the distance to which dams of certain height will back the water, at the various shoals, but the question of the best power sites, and the proper plan of development, height and location of dams, etc., for any point will depend on the special conditions favorable or unfavorable for dams and canals, the width of river bed, or flooded areas above, and the value of farming lands which may be flooded. All of which can be determined only by special investigation and surveys. It will be safe, however, to assume that a practicable site for a dam 40 feet high or under, can be found in the vicinity of any location which may be selected, and the power obtainable can be estimated by using the volume of water, or its equivalent net horse power per foot of fall, and the proposed head to be developed.

The water supply or discharge of Tallapoosa River at different points may be closely approximated from the foregoing records of Milstead, Susanna, and Sturdevant Hydrographic Stations, and also at Dadeville, and Alexander City stations, on the tributaries.

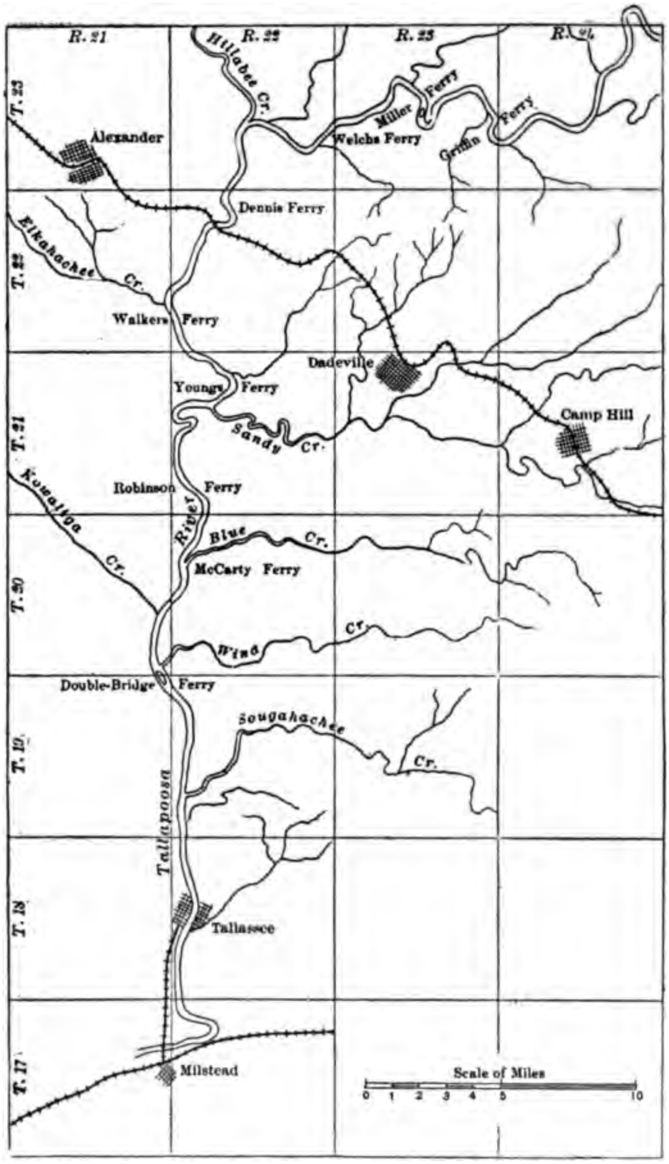

Fig. 4—Map of Tallapoosa River from top of Griffin Shoals, Ala., to Milstead, Ala.

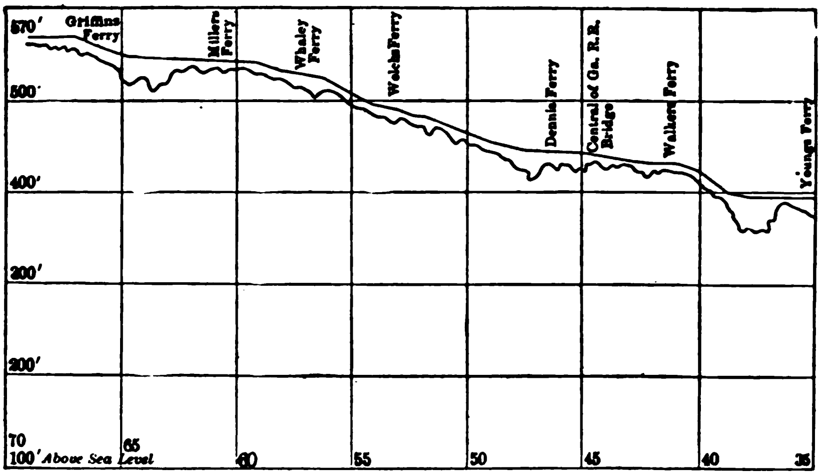

Fig. 5—Profile of Tallapoosa River from top of Griffin Shoals, Ala., to Milstead, Ala.

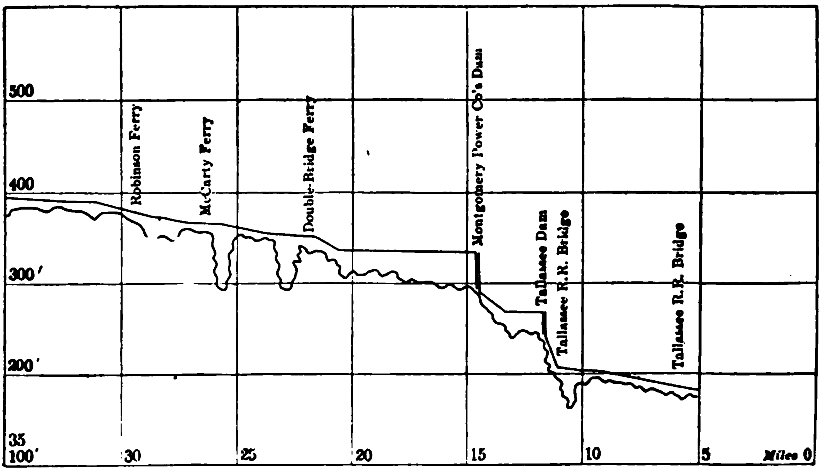

Fig. 6—Profile of Tallapoosa River from top of Griffin Shoals, Ala., to Milstead, Ala.—*Continued.*

5. BIG SANDY CREEK, NEAR DADEVILLE, ALABAMA.

This station, which was established by J. R. Hall, August 2, 1900, is located about 4½ miles southwest of Dadeville, at the highway bridge on the Dadeville-Susanna road. The gage, which is graduated to feet and tenths, is 16 feet high, and is fastened vertically to the first pier on the north side of the creek. The initial point of sounding is at the gage rod. The section is good for ordinary or flood measurements, but is rather wide and shoaly for low-water measurements. The latter can, however, be made a short distance from the gage. The observer is T. H. Finch, Dadeville, Alabama. During 1900 the following measurements were made by James R. Hall:

July 6—Gage height, 1.20 feet; discharge, 260 second-feet.
August 8—Gage height, 1.00 foot; discharge, 110 second feet.
August 8—Gage height, 1.00 foot; discharge, 116 second-feet.
August 25—Gage height, 1.35 feet; discharge, 281 second-feet.
Nov. 16—Gage height, 1.10 feet; discharge, 155 second-feet.
Dec. 31—Gage height, 2.00; discharge, 870 second-feet.

The measurements of August 8 and November 16 were made a half mile below Smith's bridge.

Daily gage height, in feet, of Big Sandy Creek near Dadeville, Ala., for 1900.

Day.	Aug.	Sept.	Oct.	Nov.	Dec
1	1.00	1.10	0.95	1.00	1.10
2	1.20	1.10	.90	1.30	1.15
3	1.10	1.40	.90	2.00	1.25
4	1.10	1.30	.90	1.80	1.40
5	1.10	1.20	3.50	1.40	1.35
6	1.05	1.05	1.80	1.20	1.30
7	1.05	1.00	1.25	1.20	1.25
8	1.00	1.00	1.20	1.20	1.20
9	1.05	.95	1.10	1.15	1.15
10	1.00	2.00	1.15	1.15	1.10
11	1.00	1.80	1.10	1.15	1.10
12	9.05	1.40	1.20	1.15	1.10
13	9.00	1.20	1.30	1.10	1.10
14	9.00	1.20	1.15	1.10	2.20
15	1.80	2.00	1.10	1.10	1.80
16	1.00	2.20	1.05	1.10	1.45
17	1.80	3.90	1.10	1.05	1.45
18	1.20	1.50	1.00	1.10	1.30
19	1.10	1.10	1.05	1.10	2.40
20	1.00	1.05	1.05	1.10	4.50
21	1.00	1.00	1.00	1.10	3.50
22	.90	1.00	1.50	1.30	1.70
23	.90	1.00	1.45	1.25	1.50
24	1.70	1.00	1.40	1.20	1.40
25	1.40	1.00	1.20	1.50	1.40
26	1.60	1.00	1.15	1.90	1.35
27	1.15	1.05	1.10	1.80	1.35
28	1.10	1.05	1.05	1.20	1.35
29	1.00	1.00	1.05	1.15	1.30
30	1.00	.90	1.00	1.10	1.75
31	1.80	......	1.05	......	2.00

Daily gage height, in feet, of Big Sandy Creek near Dadeville, Ala., for 1901.

Day.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec
1........	1.90	1.35	1.40	4.40	1.40	1.40	1.30	1.10	1.30	4.20	.85	.90
2........	1.90	1.35	1.40	7.40	1.40	1.40	1.25	1.10	1.30	4.00	.85	.90
3........	1.95	3.10	1.35	2.70	1.45	4.00	1.20	1.00	1.20	3.00	.85	1.40
4........	1.70	6.00	1.35	2.00	1.35	5.60	1.20	1.05	1.10	3.50	.85	1.40
5........	1.60	1.90	1.35	1.80	1.35	1.90	1.40	1.10	1.10	2.00	.85	1.40
6........	1.50	1.75	1.40	1.60	1.35	3.50	1.50	1.05	1.10	1.80	.90	1.30
7........	1.45	1.55	1.35	1.50	1.40	2.40	1.40	1.30	1.00	1.80	.90	1.10
8........	1.40	2.10	1.35	1.50	1.55	1.90	1.25	1.20	1.00	1.50	1.00	1.00
9........	1.40	3.50	1.40	1.50	1.35	1.50	1.20	1.10	1.00	1.40	1.00	1.10
10........	1.40	2.20	1.45	1.50	1.30	1.60	1.20	1.10	.90	1.20	1.00	1.00
11........	1.90	2.00	1.40	1.50	1.30	1.70	1.10	1.10	.90	1.20	1.00	1.00
12........	1.70	1.70	1.35	1.55	1.35	2.00	1.10	1.20	.85	1.00	.90	1.00
13........	2.50	1.50	1.35	1.65	1.35	1.80	1.10	1.15	.80	1.90	1.00	1.10
14........	1.90	1.50	1.35	1.65	1.50	1.90	1.10	1.10	1.40	1.90	1.00	4.40
15........	1.60	1.50	1.30	1.60	1.50	1.15	1.80	1.00	1.40	1.80	1.00	3.80
16........	1.55	1.45	1.30	1.50	1.45	1.70	1.50	5.00	1.80	1.80	1.00	3.00
17........	2.00	1.45	1.30	1.50	1.25	1.50	1.50	1.80	2.00	1.70	1.00	2.90
18........	2.00	1.45	1.35	1.45	1.40	1.50	1.50	1.80	1.80	1.70	.90	2.50
19........	1.60	1.50	1.35	6.00	1.40	1.45	1.30	1.40	1.80	1.70	.90	2.40
20........	1.50	1.50	1.80	2.50	1.70	1.45	1.20	1.30	1.70	1.70	.80	2.40
21........	1.50	1.45	1.60	2.40	7.00	1.40	1.15	1.20	1.40	1.60	.80	2.00
22........	1.45	1.40	1.40	2.10	3.40	1.35	1.15	4.50	1.30	1.60	1.00	2.00
23........	1.45	1.40	1.40	1.80	1.80	1.40	1.15	1.50	1.30	1.00	1.00	1.90
24........	1.45	1.50	2.20	1.80	1.70	1.40	1.10	1.50	1.20	1.00	.85	1.80
25........	1.50	1.50	2.10	1.70	1.50	1.35	1.10	1.40	1.20	.90	.85	1.50
26........	1.55	1.45	1.70	1.60	2.70	1.30	1.10	1.40	1.10	.90	.80	3.00
27........	1.45	1.45	1.70	1.45	1.80	1.30	1.15	1.20	1.00	*.70	.90	3.00
28........	1.40	1.45	1.40	1.45	1.50	1.20	1.20	2.00	1.00	*.60	.90	21.00
29........	1.40	......	1.40	1.45	1.50	1.15	1.15	1.50	1.80	*.70	.90	16.00
30........	1.40	......	2.30	1.45	1.45	1.20	1.10	1.40	1.80	*.70	.90	8.00
31........	1.40	......	13.10	......	1.40	......	1.10	1.40	......	.80	......	4.00

***Water was being held back by dams above in the morning when readings were made; 0.8 is assumed as minimum for October.**

Rating table for Big Sandy Creek at Dadeville, Ala., for 1900 and *1901.*

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
0.8	67	4.4	1,868	8.0	3,740	11.6	5,612
0.9	85	4.5	1,920	8.1	3,792	11.7	5,664
1.0	115	4.6	1,972	8.2	3,844	11.8	5,716
1.1	152	4.7	2,024	8.3	3,896	11.9	5,768
1.2	204	4.8	2,076	8.4	3,948	12.0	5,820
1.3	256	4.9	2,128	8.5	4,000	12.1	5,872
1.4	308	5.0	2,180	8.6	4,052	12.2	5,924
1.5	360	5.1	2,232	8.7	4,104	12.3	5,976
1.6	412	5.2	2,284	8.8	4,156	12.4	6,028
1.7	464	5.3	2,336	8.9	4,208	12.5	6,080
1.8	516	5.4	2,388	9.0	4,260	12.6	6,132
1.9	568	5.5	2,440	9.1	4,312	12.7	6,184
2.0	620	5.6	2,492	9.2	4,364	12.8	6,236
2.1	672	5.7	2,544	9.3	4,416	12.9	6,288
2.2	724	5.8	2,596	9.4	4,468	13.0	6,340
2.3	776	5.9	2,648	9.5	4,520	13.1	6,392
2.4	828	6.0	2,700	9.6	4,572	13.2	6,444
2.5	880	6.1	2,752	9.7	4,624	13.3	6,496
2.6	932	6.2	2,804	9.8	4,676	13.4	6,548
2.7	984	6.3	2,856	9.9	4,728	13.5	6,600
2.8	1,036	6.4	2,908	10.0	4,780	13.6	6,652
2.9	1,088	6.5	2,960	10.1	4,832	13.7	6,704
3.0	1,140	6.6	3,012	10.2	4,884	13.8	6,756
3.1	1,192	6.7	3,064	10.3	4,936	13.9	6,808
3.2	1,244	6.8	3,116	10.4	4,988	14.0	6,860
3.3	1,296	6.9	3,168	10.5	5,040	14.1	6,912
3.4	1,348	7.0	3,220	10.6	5,092	14.2	6,964
3.5	1,400	7.1	3,272	10.7	5,144	14.3	7,016
3.6	1,452	7.2	3,324	10.8	5,196	14.4	7,068
3.7	1,504	7.3	3,376	10.9	5,248	14.5	7,120
3.8	1,556	7.4	3,428	11.0	5,300	14.6	7,172
3.9	1,608	7.5	3,480	11.1	5,352	14.7	7,224
4.0	1,660	7.6	3,532	11.2	5,404	14.8	7,276
4.1	1,712	7.7	3,584	11.3	5,456	14.9	7,328
4.2	1,764	7.8	3,636	11.4	5,508	15.0	7,380
4.3	1,816	7.9	3,688	11.5	5,560		

NOTE.—This table applied to the foregoing "Daily gage heights" gives the cubic feet per second flowing in the river on each date for which the gage height is given.

Estimated monthly discharge of Big Sandy Creek near Dadeville, Ala.

[Drainage area, 195 square miles.]

Month.	Discharge in second-feet.			Total in acre-ft.	Run-off.	
	Maximum.	Minimum.	Mean.		Depth in inches.	Second-ft. per sq. mile.
1900.						
August	655	80	207	12,728	1.22	1.06
September	3,150	80	355	21,124	2.03	1.82
October	2,670	80	264	16,233	1.56	1.35
November	870	110	261	15,531	1.50	1.34
December	3,870	150	560	34,433	3.31	2.87

Estimated monthly discharge of Big Sandy Creek near Dadeville, Ala.

[Drainage area, 195 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean	Depth in inches.	Second-ft. per sq. mile.
1901.					
January	880	308	425	2.51	2.18
February	2,700	282	545	2.90	2.78
March	6,392	256	552	3.26	2.83
April	3,428	334	689	3.94	3.53
May	3,220	230	480	2.84	2.46
June	2,492	178	523	2.99	2.68
July	516	152	227	1.34	1.16
August	2,180	115	369	2.18	1.89
September	620	67	257	1.47	1.32
October	1,764	*45	462	2.73	2.37
November	115	67	92	.52	.47
December	10,500	85	1,265	7.48	6.49
The year	10,500	*45	490	34.16	2.51

*See foot note under gage heights for 1901.

Minimum monthly discharge of Big Sandy Creek at Dadeville, Ala., with corresponding net horsepower per foot of fall on a water wheel realizing 80 per cent of the theoretical power.

[Drainage area, 195 square miles.]

	1900			1901		
	Minimum cubic feet per second.	Minimum net H. P. per foot of fall.	No. of days duration of minimum.	Minimum cubic feet per second.	Minimum net H. P. per foot of fall.	No. of days duration of minimum.
January	......	......	......	308	28	7
February	......	......	......	282	26	2
March	......	......	......	256	23	3
April	......	......	......	334	30	5
May	......	......	......	230	21	1
June	......	......	......	178	16	2
July	......	......	......	152	14	9
August	80	7	4	115	10	2
September	80	7	1	67	6	1
October	80	7	3	*45	*4	1
November	110	10	1	67	6	3
December	150	14	5	85	8	2

*NOTE.—To find the minimum net horse power available at a shoal on this stream, near this station, for any month, multiply the total fall of the shoal by the "Net H. P. per foot of fall" in this table for that month.

*See foot note under gage heights for 1901.

A survey made in July, 1900, of Big Sandy Creek from its mouth to the new bridge near Dadeville, Ala., showed a total fall of 157 feet in a distance of 65,000 feet, or about 12 miles.

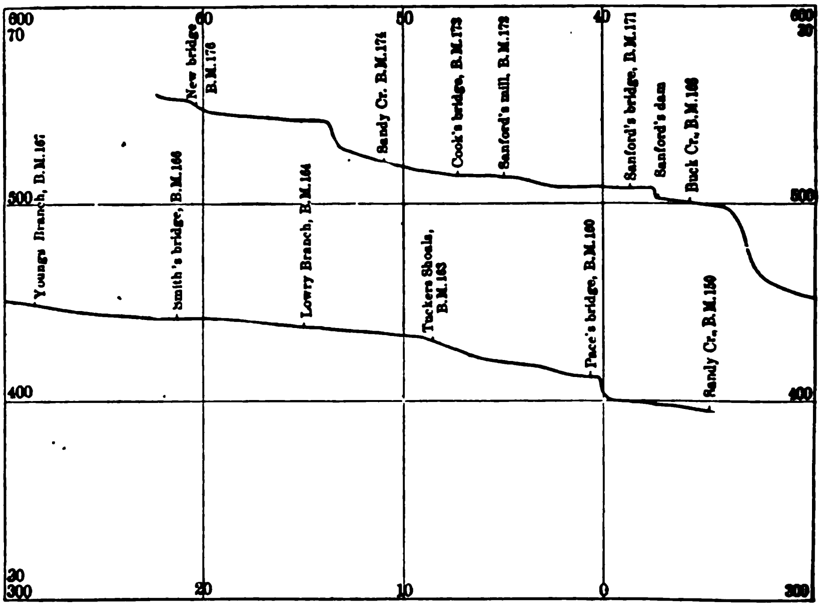

Fig. 7.—Profile of Big Sandy Creek from mouth to new bridge near Dadeville, Ala.

*Note.—The numbers 0, 10..70, represent thousand feet stations.

The profile resulting from the survey is reproduced in Fig. 7. The following list of distances and elevations of water and bench marks shows the fall of the creek from point to point.

Elevations and bench marks along Big Sandy Creek between its mouth and the new bridge near Dadeville, Ala.

Distance above mouth.	Description or location.	Bench mark elevation above sea level.	Elevation above sea level.
0	Bench mark No. 150, dead stump at mouth of creek..	398.08	
0	Water at mouth of Big Sandy Creek		393.80
5,000	Water below Pace's dam		402.00
5,000	Water above Pace's dam		412.10
5,600	Bench mark No. 160, big pine on north side, 175 feet above Pace's bridge	422.30	
8,000	Creek surface		416.00
10,000	At point of Ivy Bend		419.00
11,700	Bench mark No. 162, large walnut at Tucker's house	503.85	
13,500	Bench mark No. 163, small oak at Tucker's fish trap	432.85	
13,500	Water above Tucker's fish trap		430.00
20,000	Bench mark No. 164, large sycamore at mouth of Lowry branch	445.20	
20,000	Water at mouth of Lowry branch		436.10
26,500	Bench mark No. 166, oak post at north end of Smith's bridge	463.95	
26,000	Water at Smith's bridge		441.70
26,500	Zero of U. S. G. S. gage at Dadeville	440.50	
33,500	Bench mark No. 167, wahoo tree at mouth of Young branch	559.58	
33,500	Water at mouth of Young branch		446.50
35,360	Water at Barnes basin		452.30
37,930	Water at foot of Black Shoals		465.00
39,300	Water at top of Black Shoals		496.30
41,100	Water at mouth of Buck Creek		497.30
41,100	Bench mark No. 168, small double oak at mouth of Buck Creek	503.65	
41,900	Eddy water below Sanford's dam		500.00
42,550	Bench mark No. 169, hickory at Sanfords' mill	522.10	
42,550	Floor of Sanford's mill	514.00	
43,770	Water at Sanford's bridge above dam		506.70
45,580	Water at head of Sanford Pond		506.70
50,000	Water at second shoal above Sanford Pond		512.50
52,340	Bench mark No. 173, large white oak near north end of Cook's bridge	539.35	
52,340	Water at Cook's bridge		513.80
56,120	Water opposite mouth of Chattasofka Creek		520.60
56,120	Bench mark, 16-inch water oak on west bank of Chattasofka Creek, 50 feet above mouth	527.20	
58,620	Water at top of old factory shoal		540.15
65,350	Water at new bridge		550.80
65,350	Bench mark on upstream end of sill on west end of new bridge	562.30	
65,350	Bench mark No. 176, 6-inch maple at new bridge	563.00	

Water supply of this creek is shown by the foregoing records of Dadeville Hydrographic Station at Smith's Bridge.

The best shoal on this creek is the Sanford and Black Shoal, near Dadeville, which has a fall of 85.8 feet, in a distance of 5.2 miles. With a dam 54 feet high, and a canal 1,370 feet long, a practical working head of 80 feet can be developed, having 1 foot extra for grade of canal, and 4 feet extra for storage at top of dam. The foregoing record shows that from

August 1, 1900, to December 31, 1901, covering a record of 515 days, there were only 37 days in which the flow at Smith's Bridge was less than 115 cubic feet per second. It is, therefore, plain that during the last two years such a plant would have realized, for 90 per cent. of the time, not less than 800 net horse power continuously, 24 hours per day: and that by running 11 hours per day, 6 days per week, and storing the water during the time that the wheels are standing, there would have been 2,000 H. P. or more for use during factory hours, for 90 per cent. of the time during the last two years. By applying the rating table to the gage heights, and finding the discharge for each individual day, the exact power obtainable can be calculated, due allowance being made for the storage capacity, and equalizing effect of the dam.

Of course, this 85 foot fall can be developed in other ways. A low dam, and long canal can be used, or two separate powers can be developed.

6. HILLABEE CREEK, NEAR ALEXANDER CITY, ALABAMA

This station, which was established August 20, 1900, by J. R. Hall, is located 6½ miles northeast of Alexander City, on the road leading from that town to Newsite. The gage which is graduated to feet and tenths, and is placed vertically, is in two sections, the short section, which reads from 0 to 5.50 feet, being fastened to a post in the edge of the water on the north bank 20 feet from the upstream side of the bridge, the long section, which reads from 5.50 feet to 16 feet, being fastened to the upstream end of the first pier on the north bank, and arranged so that when water rises above the short section the readings are made from the long one, both sections being easily read from the north approach to the bridge. The initial point of sounding is on the south side of the first pier on the north bank. The gage is referred to a bench mark at the top of a chord on the dawnstream side of the bridge at the second pier from the north bank, and is 27.6 feet above the zero of the gage. The bridge is in three spans, having a tptal length of 276 feet, with a north approach of 116 feet and a south approach of 124 feet, making a total, over all, of 516 feet. The observer is J. H. Chisholm, a farmer, postoffice address Alexander City, Ala. During 1900 the following measurements were made by James R. Hall:

August 29: Gage height, 1.40 feet; discharge 184 second-feet.
November 28: Gage height, 2 feet; discharge, 390 second-feet.

Daily gage height of Hillabee Creek at Alexander City, Ala., for 1900.

Day.	Aug.	Sept.	Oct.	Nov.	Dec	Day.	Aug.	Sept.	Oct.	Nov.	Dec
1	......	2.30	1.30	1.60	1.90	17	......	2.60	1.30	1.50	2.70
2	......	2.30	1.10	2.60	1.90	18	......	2.20	1.30	1.40	2.80
3	......	1.60	1.10	6.80	1.80	19	......	1.60	1.20	1.50	3.00
4	......	1.40	1.10	3.20	1.90	20	......	1.50	1.20	1.60	2.90
5	......	1.30	3.20	2.20	1.80	21	......	1.50	1.20	1.70	6.00
6	......	1.20	2.00	1.80	1.90	22	......	1.40	1.90	2.10	4.00
7	......	1.20	2.80	1.70	1.80	23	......	1.20	5.90	1.90	3.00
8	......	1.10	2.60	1.70	1.70	24	......	1.30	2.90	1.90	2.90
9	......	1.10	2.40	1.80	1.70	25	......	1.40	2.10	5.10	2.90
10	......	1.20	2.30	1.70	1.70	26	......	1.30	1.90	2.90	2.80
11	......	1.10	2.30	1.70	1.70	27	......	1.40	1.80	2.40	2.60
12	......	1.10	1.80	1.70	1.70	28	......	1.30	1.70	2.00	2.50
13	......	1.10	1.60	1.70	1.80	29	1.40	1.40	1.60	1.90	2.50
14	......	1.10	1.40	1.70	3.80	30	1.30	1.30	1.50	1.90	5.80
15	......	8.10	1.40	1.70	2.90	31	1.80	......	1.50	......	5.70
16	......	5.00	1.20	1.60	2.80						

Daily gage height of Hillabee Creek at Alexander City, Ala., for 1901.

Day	Jan.	Feb.	Mar.	April	May	Jun	July	Aug.	Sept.	Oct.	Nov.	Dec
1	5.00	2.40	2.30	5.20	2.50	2.50	.50	1.80	2.60	1.20	1.00	1.00
2	4.90	2.40	2.30	4.40	2.50	2.40	.50	1.40	2.00	1.20	1.00	1.00
3	4.90	4.60	2.40	4.80	2.50	3.00	.40	1.40	1.40	1.10	1.00	2.00
4	4.70	9.40	2.40	3.10	2.40	2.50	2.30	1.20	1.20	1.10	1.00	1.60
5	3.90	6.00	2.30	2.90	2.40	2.50	2.00	1.10	1.10	1.10	1.30	1.40
6	3.60	4.10	2.20	2.80	2.40	2.60	.80	1.10	1.10	1.20	1.10	1.30
7	3.60	3.60	2.10	2.70	2.40	2.50	90	1.10	1.10	1.40	1.10	1.20
8	3.40	3.10	2.10	2.60	2.40	2.50	10	1.00	1.10	1.20	1.00	1.20
9	2.60	3.60	2.10	2.60	2.30	2.40	1.80	1.20	1.10	1.20	1.00	1.20
10	2.50	3.00	2.40	2.50	2.30	2.40	1.80	1.20	1.10	1.20	1.00	1.90
11	8.00	2.90	2.50	2.50	2.30	2.30	1.70	1.10	1.00	1.60	1.00	1.50
12	7.60	2.90	2.30	2.40	2.20	2.00	1.60	1.10	1.00	2.00	1.00	1.40
13	7.00	2.80	2.20	3.10	2.50	2.10	1.50	1.20	1.20	2.90	1.00	1.40
14	5.90	3.00	2.20	2.90	2.30	2.00	1.40	1.60	2.50	1.60	1.00	2.00
15	4.50	3.10	2.30	2.80	2.50	2.00	1.30	2.10	2.40	1.40	1.00	3.00
16	4.30	2.60	2.40	2.70	2.20	1.90	1.40	4.40	2.40	1.20	1.00	3.00
17	4.00	2.60	2.20	2.60	2.20	2.20	1.30	2.90	2.00	1.00	1.00	2.80
18	3.50	2.40	2.20	2.60	2.10	1.90	3.40	2.00	1.80	1.00	1.00	2.70
19	3.40	2.60	2.10	10.00	2.10	1.80	2.20	2.00	1.60	1.00	1.30	2.60
20	3.00	2.70	2.10	3.20	2.90	1.80	1.80	4.00	1.40	1.00	1.30	2.00
21	2.90	2.60	3.00	3.10	3.80	1.70	2.00	4.10	1.20	1.00	1.30	1.50
22	2.90	2.40	2.40	3.00	2.90	1.70	1.90	3.40	1.40	1.00	1.30	1.50
23	2.80	2.60	2.30	2.90	2.50	1.60	1.80	3.10	1.20	1.00	1.30	1.50
24	2.60	2.60	2.80	2.80	2.50	1.60	1.80	2.90	1.10	1.00	1.30	1.60
25	2.50	2.50	2.70	2.70	2.40	1.70	1.70	2.20	1.10	1.00	1.20	1.60
26	2.60	2.40	3.50	2.60	3.90	1.70	1.70	2.20	1.20	1.00	1.20	1.70
27	2.60	2.40	3.00	2.50	2.80	1.80	1.40	2.10	2.10	1.00	1.10	1.70
28	2.50	2.40	2.70	2.50	2.60	1.80	1.60	3.80	1.60	1.00	1.10	1.80
29	2.40	......	2.60	2.50	2.50	1.70	1.40	3.60	1.40	1.00	1.10	11.00
30	2.40	......	2.70	2.50	2.30	2.60	1.40	3.40	1.20	1.00	1.10	4.90
31	2.40	......	5.20	......	2.90	....	2.00	3.00	......	1.00	......	3.90

Rating table for Hillabee Creek at Alexander City, Ala., for years 1900 and 1901.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second Ft.*	*Feet.*	*Second Feet.*	*Feet.*	*Second Ft.*
1.0	138	2.4	566	3.8	1,182
1.1	146	2.5	610	3.9	1,226
1.2	156	2.6	564	4.0	1,270
1.3	169	2.7	698	4.1	1,314
1.4	184	2.8	742	4.2	1,358
1.5	204	2.9	786	4.3	1,402
1.6	230	3.0	830	4.4	1,446
1.7	263	3.1	874	4.5	1,490
1.8	303	3.2	918	4.6	1,534
1.9	346	3.3	962	4.7	1,578
2.0	390	3.4	1,006	4.8	1,622
2.1	434	3.5	1,050	4.9	1,666
2.2	478	3.6	1,094	5.0	1,710
2.3	522	3.7	1,138		

NOTE.—This table applied to the foregoing "Daily Gage Heights" gives the cubic feet per second flowing in the river on each date for which the gage height is given.

Estimated monthly discharge of Hillabee Creek near Alexander City, Ala.

[Drainage area, 214 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Depth in inches.	Second-feet per square mile.
1900.					
September	3,074	146	370	1.93	1.73
October	2,106	146	387	2.09	1.81
November	2,502	184	471	2.45	2.20
December	2,150	263	716	3.86	3.35
1901.					
January	3,030	566	1,198	6.46	5.60
February	3,646	566	920	4.48	4.30
March	1,798	434	617	3.32	2.88
April	3,910	566	911	4.75	4.26
May	1,226	434	624	3.37	2.92
June	830	230	439	2.29	2.05
July	1,006	169	357	1.93	1.67
August	1,446	138	535	2.89	2.50
September	654	138	249	1.29	1.16
October	786	138	181	.98	.85
November	169	138	148	.77	.69
December	4,350	138	526	2.84	2.46
The year	4,350	138	559	35.37	2.61

Minimum monthly discharge of Hillabee Creek at Alexander City, Ala., with corresponding net horsepower per foot of fall on a water wheel realizing 80 per cent of the theoretical power.

[Drainage area, 214 square miles.]

	1900			1901		
	Minimum cubic feet per second.	Minimum net H. P. per foot of fall.	No. of days duration of minimum.	Minimum cubic feet per second.	Minimum net H. P. per foot of fall.	No. of days duration of minimum.
January	......	......	......	566	51	3
February	......	......	......	566	51	7
March	......	......	......	434	40	5
April	......	......	......	566	51	1
May	......	......	......	434	40	2
June	......	......	......	230	21	2
July	......	......	......	169	15	2
August	169	15	1	138	13	1
September	146	13	6	138	13	2
October	146	13	3	138	13	15
November	184	17	1	138	13	15
December	263	24	5	138	13	2

NOTE.—To find the minimum net horse power available at a shoal on this stream, near this station, for any month, multiply the total fall of the shoal by the "Net H. P. per foot of fall" in this table for that month.

7. ALABAMA TRIBUTARIES OF THE TALLAPOOSA RIVER, FROM MILSTEAD UP.

From which side.	Name of Stream.	Point on stream.	Drainage area, sq. miles.	Estimated discharge cu. ft. per sec. low water 1900-1901.	Net H.P. per ft. of fall on 80 per cent. turbine.
Left..	Uphapee Creek.............	Mouth of Creek......	450	45	4.1
Left..	Uphapee Creek.............	Chehaw, Ala..........	360	40	3.6
Left..	Sougahatchee Creek.......	Mouth of Creek......	240	48	4.3
Right	Cedar Creek................	Mouth of Creek......	55	14	1.3
Left..	Wind Creek.................	Mouth of Creek......	25	8	0.7
Right	Kowaliga Creek............	Mouth of Creek......	135	40	3.6
Right	Kowaliga Creek............	Kowaliga, Ala........	115	35	3.2
Left..	Blue Creek..................	Mouth of Creek......	60	20	1.8
Left..	Big Sandy Creek...........	Mouth of Creek......	200	70	6.3
Left..	Big Sandy Creek...........	Smith's Bridge........	195	67	6.1
Right	Elkahatchee Creek........	Mouth of Creek......	75	37	3.3
Right	Hillabee Creek.............	Mouth of Creek......	220	141	12.8
Right	Hillabee Creek.............	Chisholme's Bridge...	214	138	12.6
Right	Emuckfaw Creek..........	Mouth of Creek......	78	46	4.2
Left..	Cohoasanocsa Creek......	Mouth of Creek......	70	42	3.8
Left..	High Pine Creek...........	Mouth of Creek......	82	49	4.4
Right	Hurricane Creek...........	Mouth of Creek......	14	8	0.7
Left..	Corn House Creek.........	Mouth of Creek......	72	43	3.9
Right	Crooked Creek.............	Mouth of Creek......	95	57	5.2
Right	Fox Creek...................	Mouth of Creek......	37	22	2.0
Left..	Little Tallapoosa River...	Mouth of River......	590	354	32.2
Left..	Little Tallapoosa River...	Ala.-Ga. State Line..	311	186	16.9
Left..	Tallapoosa River..........	Above Little Tallapoosa River	767	460	41.8
Right	Ketchepedrakee Creek....	Mouth of Creek......	49	29	2.6
Right	Cane Creek.................	Mouth of Creek......	55	33	3.0
Right	Muscadine Creek...........	Mouth of Creek......	36	21	1.9
Right	Tallapoosa River..........	Ala.-Ga. State Line..	302	181	16.4

Note.—To find the net horse power available at a shoal on one of the streams near a given point, for low water 1900-1901, multiply the total fall of the shoal by the "Net H. P. per foot of fall' in this table.

All of these tributaries to the Tallapoosa River are in the Crystalline region, and are very precipitous streams, having fine shoals all along their courses.

No State or Government Surveys have ever been made to determine their profiles, and it is, therefore, impossible at present to make a detailed statement of the water powers. The tabulated statement given above shows the cubic feet per second flowing in the streams, at certain places during low season of ordinary years, like 1900 and 1901.

This flow at any point multiplied by the total practical fall in feet that can be brought upon a water wheel on the given stream at that point, and divided by 11 gives the net available horse power at that point, during low season of a year like 1900 or 1901.

The "Cubic feet per second" flowing at the given points and the corresponding "Drainage areas" can be used to get by proportion the discharge at other points of same stream whose drainage areas are known.

Actual discharge measurements have been made on these streams at various points and at various stages of water, as is shown by the following list of Miscellaneous Discharge Measurements. As that date of these measurements are given, the stage of water as related to minimum for 1900-1901 can be approximated by noting the stage at regular stations on the same dates.

Miscellanous discharge measurements made by James R. Hall on tributaries of Tallapoosa River.

1900.

August 2—Sougahatchee Creek, Meaders bridge; discharge 125 second-feet.

August 3—Blue Creek, Susanna, Ala., postoffice; 34 second-feet.

August 28—Elkahatchee Creek, Island Home postoffice; discharge, 184 second-feet.

August 30—Timber Cut Creek, Near Welches Ferry; discharge, 18 second-feet.

December 12—Chattasofka Creek, New Bridge, near Dadeville; discharge, 35 second-feet.

1901.

February 11—Wind Creek, Starr's bridge, near Meltons Mill postoffice; discharge, 66 second-feet.

February 11—Sougahatchee Creek, Lovelady's bridge, near Thadeus; discharge 453 second-feet.

February 13—Blue Creek, Farrows Mill, Susanna postoffice; discharge 117 second-feet.

February 13—Channahatchee Creek, Freeman's Mill, Channahatchee postoffice; discharge 80 second-feet.

February 27—Kowaliga Creek, Benson's bridge, Kowaliga postoffice; discharge 154 second-feet.

March 5—Emuckfaw Creek, Hamlett's Mill, Zana postoffice; discharge 113 second-feet.

March 11—Moore's Creek, near Dudleyville; discharge 29 second-feet.

March 12—Chattahaspa Creek, Scott's Mill, near Tiller Crossroads postoffice; discharge 203 second-feet.

March 12—Cohoasanocsa Creek, Leverett's Mill, near Milltown postoffice; discharge 122 second-feet.

March 12—High Pine Creek, Lile's Gin, Happy Land postoffice; discharge 89 second-feet.

March 12—Beaver Dam Creek, near Louina postoffice; discharge 30 second-feet.

March 13—Corn House Creek, Swann's Store, near Level Road postoffice; discharge 31 second-feet.

March 13—Wild Cat Creek, Murphy's Mill, near Gay postoffice; discharge, 32 second-feet.

March 13—Tallapoosa River, below mouth of Little Tallapoosa River, near Goldburg; discharge, 2,400 second-feet.

March 13—Crooked Creek, near Goldberg; discharge 183 second-feet.

March 13—Hurricane Creek, near Almond postoffice; discharge, 29 second-feet.

CHAPTER III.

COOSA RIVER AND TRIBUTARIES.

The Regular Stations that will be used in the folowing discussion are: Riverside, Ala., and Rome, Ga., on the Coosa River; and Nottingham, Ala., on Talladega Creek. Numerous miscellaneous discharge measurements at other points will also be used.

Under the heading of each station all the investigations made at the station are given, together with the facts deduced therefrom.

1. RIVERSIDE STATION ON COOSA RIVER.

This station is at Riverside, Ala., in the Springville quadrangle of the United States Geological Survey map, in latitude 33° 37' and longitude 85° 12', at the bridge of the Southern Railway, Georgia Pacific Division, across the Coosa River. The river here flows in a southerly direction, the railroad running from east to west. The town of Riverside is on the right or west bank of the river, and the railroad depot is about 1,000 feet west of the bridge, which is of iron and about 30 feet above low water. Beginning at the left bank, there are two spans of 154 feet each; then a drawbridge 220 feet, revolving on a large center pier; then a stationery span, 80 feet in length, to west or right bank abutment. There is no running water at low stages under the last-named span.

At low water the flowing river is 480 feet wide, including three piers, and is from 4 to 10 feet deep. Very little of the current is too slow to turn any meter. It is somewhat irregular, as there are shoals and some old cribs just above the bridge, but for all stages it is probably the best station that can be found on the river at a bridge and easy of access.

On September 8, 1896, a discharge measurement was made by B. M. Hall, and two bench marks were established. On September 22, 1896, another discharge measurement was made, a wire gage was put in, and Mr. J. W. Foster, sawyer at a large sawmill about 300 feet distant, on right bank of river, below the bridge, was employed as observer.

The initial point is top of left abutment at the edge toward the river, on the downstream side of the bridge, from which side soundings and meter measurements are made. The rod of wire gage is nailed to outside guard rail, downstream side, next to the last panel of stationary bridge before reaching the pier at end of draw span. The rod is 14 feet long and divided to feet and tenths. The bench mark is the top of capstone on the large circular center pier of turn span. It is 26.80 feet above datum of gage at downstream side of pier.

The drainage area is 6,850 square miles, and is mapped on atlas sheets Springville, Anniston, Gadsden, Fort Payne, Rome, Tallapoosa, Marietta, Cartersville, Suwanee, Ellijay, Dalton, Cleveland, Ringgold, and Stevenson of the United States Geological Survey.

The following discharge measurements were made during 1896 by B. M. Hall and others:

September 8: Gage height, 0.70 feet; discharge, 1,630 second-feet.
September 25: Gage height, 0.50 feet; discharge, 1,403 second-feet.
October 30: Gage height, 0.88 feet; discharge, 1,986 second-feet.
December 21: Gage height, 1.57 feet; discharge, 3,272 second-feet.

Daily gage height in feet of Coosa river at Riverside, Ala., for 1896.

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
1	......	0.60	1.10	1.30	17	......	0.55	4.70	2.10
2	......	1.75	1.40	2.10	18	......	.65	4.20	2.20
3	......	3.10	1.20	4.38	19	......	.80	3.20	2.00
4	......	2.75	1.10	3.80	20	......	.85	2.30	1.80
5	......	2.00	1.05	3.20	21	......	.75	1.50	1.70
6	......	1.50	1.10	2.50	22	......	.70	1.40	1.50
7	......	1.20	1.20	2.20	23	......	.60	1.35	1.45
8	......	.85	2.55	1.90	24	......	.55	1.30	1.40
9	......	.70	2.30	1.70	25	......	.60	1.25	1.35
10	......	.60	1.90	1.60	26	......	.70	1.20	1.30
11	......	.65	1.30	1.55	27	.45	.80	1.15	1.25
12	......	.60	1.60	1.55	28	.45	.85	1.15	1.20
13	......	.60	2.25	1.60	29	.45	.90	1.10	1.10
14	......	.60	2.70	1.60	30	.50	.95	1.20	1.10
15	......	.55	4.00	1.80	31	......	.85	......	1.10
16	......	.55	5.20	2.00					

Rating table for Coosa River at Riverside, Ala., for 1896.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height	Discharge.
Feet.	*Second Ft.*	*Feet.*	*Second Ft.*	*Feet.*	*Second Ft.*
0.5	1,400	2.1	4,630	3.7	9,640
0.6	1,500	2.2	4,920	3.8	9,980
0.7	1,630	2.3	5,200	3.9	10,330
0.8	1,780	2.4	5,500	4.0	10,680
0.9	1,930	2.5	5,800	4.1	11,030
1.0	2,100	2.6	6,100	4.2	11,390
1.1	2,280	2.7	6,400	4.3	11,750
1.2	2,480	2.8	6,700	4.4	12,110
1.3	2,680	2.9	7,010	4.5	12,470
1.4	2,880	3.0	7,320	4.6	12,840
1.5	3,090	3.1	7,640	4.7	13,210
1.6	3,320	3.2	7,970	4.8	13,580
1.7	3,560	3.3	8,300	4.9	13,950
1.8	3,820	3.4	8,630	5.0	14 330
1.9	4,080	3.5	8,960	5.1	14,710
2.0	4,360	3.6	9,300	5.2	15,100

NOTE.—This table applied to the foregoing "Daily gage heights" gives the cubic feet per second flowing in the river on each date for which the gage height is given.

The following discharge measurements were made during 1897 by Max Hall and others:

March 31: Gage height, 4.53 feet; discharge, 12,515 second-feet.
June 17: Gage height, 1.54 feet; discharge, 3,747 second-feet.
July 21: Gage height, 5.55 feet; discharge, 16,925 second-feet.
August 20: Gage height, 2.58 feet; discharge, 6,174 second-feet.
November 29: Gage height, 0.80 feet; discharge, 1,854 second-feet.

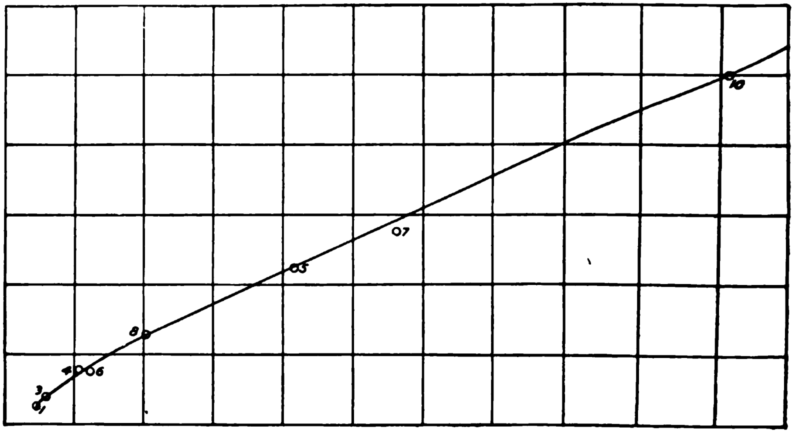

Fig. 8.—Rating curve for Riverside station on Coosa River, Ala.

Daily gage height, in feet, of Coosa River, at ***Riverside, Ala.,*** *for 1897.*

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec
1..........	1.10	2.00	5.00	4.30	3.40	1.90	1.45	2.00	1.20	0.50	0.70	0.80
2..........	1.10	2.50	4.50	4.45	3.10	1.90	1.45	1.80	1.10	.50	.70	.90
3..........	1.10	5.35	4.25	5.20	3.05	1.90	1.40	1.60	1.30	.50	.70	.95
4..........	1.10	7.35	3.90	7.00	3.60	1.85	1.40	1.50	1.60	.50	.65	1.20
5..........	1.10	7.70	4.20	8.60	3.20	1.85	1.45	1.45	1.30	.45	.80	2.50
6..........	1.20	7.90	5.80	9.50	3.00	1.80	1.50	1.40	1.20	.45	1.05	3.00
7..........	1.25	9.00	11.40	10.50	3.80	1.90	1.50	1.50	1.10	.45	1.15	2.90
8..........	1.30	7.70	13.30	11.15	3.70	2.15	2.40	1.50	1.00	.45	1.10	2.40
9..........	1.35	6.40	12.55	12.15	2.65	2.10	2.30	1.60	.90	.45	1.00	2.15
10..........	1.35	5.90	12.65	11.90	2.60	1.90	2.05	1.70	.85	.45	.95	2.00
11..........	1.35	5.20	12.70	10.70	2.50	1.90	2.50	1.70	.80	.40	.85	1.70
12..........	1.30	7.35	12.80	9.10	2.55	2.00	2.70	2.00	.80	.40	.85	1.60
13..........	1.40	8.30	13.45	7.30	2.65	1.90	2.50	2.50	.75	.45	.85	1.60
14..........	2.00	8.20	14.80	6.05	2.10	1.85	2.00	2.30	.75	.45	.85	2.00
15..........	3.50	7.50	14.60	5.60	3.90	1.60	1.80	2.00	.80	1.45	.80	2.50
16..........	4.00	6.60	14.80	5.30	4.00	1.70	1.70	1.80	.85	1.65	.75	3.00
17..........	4.90	5.70	14.70	5.60	4.00	1.50	1.80	1.60	.85	1.40	.70	3.30
18..........	5.35	5.00	14.70	5.40	3.60	1.60	1.95	1.50	.80	1.35	.70	3.15
19..........	5.00	4.50	14.50	5.00	3.20	1.90	2.00	1.90	.80	1.20	.70	2.65
20..........	4.80	4.00	15.30	4.60	3.00	2.00	3.00	2.60	.75	1.00	.65	2.10
21..........	6.50	4.60	14.90	4.30	2.70	1.80	5.20	2.00	.75	.90	.65	2.20
22..........	7.00	4.65	14.70	4.00	2.35	1.70	6.40	1.70	.70	.85	.65	2.80
23..........	7.35	6.00	14.50	3.80	2.30	1.60	8.00	1.60	.70	.80	.65	4.20
24..........	7.00	7.90	13.70	3.60	2.25	1.55	6.20	1.70	.70	.70	.65	4.85
25..........	5.40	9.00	12.20	3.40	2.25	1.50	4.50	1.75	.65	.80	.65	4.95
26..........	4.70	9.00	10.60	3.30	2.15	1.45	4.00	1.60	.65	.75	.65	4.55
27..........	3.80	8.00	8.50	3.25	2.05	1.45	3.00	1.60	.60	.60	.65	3.85
28..........	3.00	6.20	6.50	2.20	2.00	1.40	2.60	1.50	.55	.65	.65	3.20
29..........	2.70	......	5.30	3.10	2.00	1.45	2.50	1.40	.55	.80	.70	2.95
30..........	2.50	......	4.90	3.20	1.95	1.45	3.00	1.35	.55	.75	.75	2.85
31..........	2.20	......	4.60	......	1.90	....	2.60	1.30	......	.70	......	2.50

Rating table for Coosa River at Riverside, Ala., for 1897.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second Ft.*	*Feet.*	*Second Ft.*	*Feet.*	*Second Ft.*
0.4	1,350	2.0	4,520	5.0	14,046
0.5	1,400	2.2	5,100	6.0	17,306
0.6	1,500	2.4	5,700	7.0	20,566
0.7	1,650	2.6	6,300	8.0	23,826
0.8	1,820	2.8	6,910	9.0	27,086
0.9	2,010	3.0	7,530	10.0	30,346
1.0	2,210	3.2	8,178	11.0	33,606
1.2	2,630	3.4	8,830	12.0	36,866
1.4	3,070	3.6	9,482	13.0	40,126
1.6	3,540	3.8	10,134	14.0	43,386
1.8	4,020	4.0	10,786		

NOTE.—This table applied to the foregoing "Daily gage heights" gives the cubic feet per second flowing in the river on each date for which the gage height is given.

The following discharge measurements were made during 1898 by Max Hall and others:

January 27: Gage height, 10.00 feet; discharge, 30,359 second-feet.
March 9: Gage height, 1.60 feet; discharge, 3,538 second-feet.
May 3: Gage height, 3.22 feet; discharge, 7,758 second-feet.
May 25: Gage height, 1.39 feet; discharge, 3,172 second-feet.
August 3: Gage height, 3.92 feet; discharge, 9,524 second-feet.
September 7: Gage height, 11.05 feet; discharge, 37,811 second-feet.
October 19: Gage height, 6.80 feet; discharge, 14,484 second-feet.
November 22: Gage height, 5.85 feet; discharge, 16,384 second-feet.

Daily gage height, in feet, of Coosa River at Riverside, Ala., for 1898.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec
1..........	2.30	6.00	1.65	6.80	3.90	1.30	1.15	4.25	2.20	2.20	2.60	3.70
2..........	2.15	5.25	1.70	7.50	3.60	1.25	1.05	4.00	1.80	1.80	2.50	4.00
3..........	2.10	4.00	1.80	6.80	3.30	1.20	1.00	4.10	1.75	1.70	2.50	3.90
4..........	2.00	3.25	1.80	5.50	3.05	1.20	.95	4.00	5.80	2.00	2.45	3.70
5..........	1.90	3.00	1.80	5.80	2.90	1.30	.95	3.30	9.30	6.80	2.40	3.70
6..........	1.85	2.80	1.75	9.30	2.70	1.25	.90	4.00	10.20	11.20	2.40	3.90
7..........	1.75	2.75	1.70	10.50	2.55	1.20	.95	5.50	11.00	11.90	2.40	4.00
8..........	1.70	2.70	1.70	10.80	2.40	1.10	1.00	5.30	11.30	15.80	2.40	4.00
9..........	1.65	2.60	1.65	10.40	2.30	1.05	1.15	4.50	11.60	14.70	2.45	3.70
10..........	1.60	2.50	1.65	8.90	2.20	1.05	1.65	4.30	10.80	12.50	2.55	3.30
11..........	1.60	2.40	1.60	7.50	2.15	1.00	2.15	4.50	8.70	12.00	2.75	3.25
12..........	1.65	2.30	1.60	6.00	2.10	1.48	2.15	4.70	5.80	11.20	2.75	3.10
13..........	1.80	2.30	1.70	5.00	2.00	1.10	2.10	6.70	4.75	8.80	2.70	3.00
14..........	2.00	2.20	1.80	4.40	1.95	1.25	2.15	5.90	4.10	5.50	2.65	2.90
15..........	3.10	2.10	2.00	4.00	1.90	1.15	2.05	4.70	3.40	4.40	2.70	2.80
16..........	3.00	2.00	2.25	3.70	1.85	1.00	2.30	3.70	3.00	3.60	2.80	2.65
17..........	2.80	1.95	3.00	3.50	1.80	1.65	3.10	3.00	2.70	3.00	3.00	2.60
18..........	2.60	1.90	4.75	4.00	1.75	1.70	3.05	2.75	2.50	3.50	3.15	2.60
19..........	2.80	1.85	5.60	5.10	1.70	1.65	2.50	2.55	2.25	5.40	3.25	2.70
20..........	3.00	1.80	4.70	5.80	1.60	1.55	1.90	2.45	2.20	6.40	3.70	2.90
21..........	4.10	1.80	4.00	5.50	1.70	1.95	1.65	2.40	2.15	6.30	4.20	4.00
22..........	5.80	1.80	3.25	4.00	1.65	2.10	1.50	2.40	2.20	6.00	5.15	3.80
23..........	6.05	1.75	3.00	4.50	1.55	2.30	1.35	2.35	2.55	5.80	7.00	3.10
24..........	6.50	1.75	2.75	5.75	1.50	2.50	1.25	2.30	3.55	5.00	5.90	3.00
25..........	7.20	1.70	2.30	7.10	1.45	2.05	1.20	2.15	4.30	4.35	5.20	2.75
26..........	9.00	1.70	2.15	7.80	1.40	1.75	1.40	2.00	3.90	4.00	4.90	2.70
27..........	10.20	1.70	2.00	7.45	1.55	1.50	2.35	1.80	3.40	3.75	4.60	2.50
28..........	10.65	1.65	2.00	6.45	1.70	1.60	3.15	2.00	3.15	3.30	4.20	2.40
29..........	10.45	......	2.30	5.50	1.60	1.45	3.10	2.50	3.00	3.00	4.00	2.30
30..........	9.45	......	3.00	4.75	1.45	1.30	3.40	3.00	2.75	2.75	3.80	2.30
31..........	7.55	......	4.50	......	1.35	....	4.00	2.60	......	2.70	......	2.40

Rating table for Coosa River at Riverside, Ala., for 1898.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.9	2,140	4.7	12,301	8.5	25,335	12.3	46,960
1.0	2,320	4.8	12,644	8.6	25,678	12.4	47,680
1.1	2,520	4.9	12,987	8.7	26,021	12.5	48,400
1.2	2,720	5.0	13,330	8.8	26,364	12.6	49,120
1.3	2,925	5.1	13,673	8.9	26,707	12.7	49,840
1.4	3,130	5.2	14,016	9.0	27,050	12.8	50,560
1.5	3,340	5.3	14,359	9.1	27,433	12.9	51,280
1.6	3,550	5.4	14,702	9.2	27,800	13.0	52,000
1.7	3,760	5.5	15,045	9.3	28,175	13.1	52,720
1.8	3,970	5.6	15,388	9.4	28,550	13.2	53,440
1.9	4,185	5.7	15,731	9.5	28,965	13.3	54,160
2.0	4,400	5.8	16,074	9.6	29,380	13.4	54,885
2.1	4,620	5.9	16,417	9.7	29,815	13.5	55,600
2.2	4,840	6.0	16,760	9.8	30,250	13.6	56,320
2.3	5,070	6.1	17,103	9.9	30,725	13.7	57,040
2.4	5,300	6.2	17,446	10.0	31,200	13.8	57,760
2.5	5,540	6.3	17,789	10.1	31,725	13.9	58,480
2.6	5,780	6.4	18,132	10.2	32,250	14.0	59,200
2.7	6,030	6.5	18,475	10.3	32,825	14.1	59,920
2.8	6,280	6.6	18,818	10.4	33,400	14.2	60,640
2.9	6,540	6.7	19,161	10.5	34,067	14.3	61,360
3.0	6,800	6.8	19,540	10.6	34,725	14.4	62,080
3.1	7,080	6.9	19,847	10.7	35,442	14.5	62,800
3.2	7,360	7.0	20,190	10.8	36,160	14.6	63,520
3.3	7,655	7.1	20,533	10.9	36,880	14.7	64,240
3.4	7,950	7.2	20,876	11.0	37,600	14.8	64,960
3.5	8,260	7.3	21,219	11.1	38,320	14.9	65,680
3.6	8,570	7.4	21,562	11.2	39,040	15.0	66,400
3.7	8,895	7.5	21,905	11.3	39,760	15.1	67,120
3.8	9,220	7.6	22,248	11.4	40,480	15.2	67,840
3.9	9,560	7.7	22,591	11.5	41,200	15.3	68,560
4.0	9,900	7.8	22,934	11.6	41,920	15.4	69,280
4.1	12,243	7.9	23,277	11.7	42,640	15.5	70,000
4.2	10,586	8.0	23,620	11.8	43,360	15.6	70,720
4.3	10,929	8.1	23,963	11.9	44,080	15.7	71,440
4.4	11,272	8.2	24,306	12.0	44,800	15.8	72,160
4.5	11,615	8.3	24,649	12.1	45,520	15.9	72,880
4.6	11,958	8.4	24,992	12.2	46,240	16.0	73,600

NOTE.—This table applied to the foregoing "Daily gage heights" gives the cubic feet per second flowing in the river on each date for which the gage height is given.

The following discharge measurements were made during 1899 by Max Hall and others:

April 26: Gage height, 9.00 feet; discharge, 29,069 second-feet.
May 3: Gage height, 4.05 feet; discharge, 10,592 second-feet.
May 20: Gage height, 2.70 feet; discharge, 6,276 second-feet.
June 14: Gage height, 2.20 feet; discharge, 5,010 second-feet.
August 26: Gage height, 1.42 feet; discharge, 3,791 second-feet.
September 23: Gage height, 1.00 foot; discharge, 2,457 second-feet.
November 7: Gage height, 0.85 foot; discharge, 2,271 second-feet.
December 9: Gage height, 1.20 feet; discharge, 2,727 second-feet.

Daily gage height, in feet, of Coosa River at Riverside, Ala., for 1899.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec
1	2.80	5.90	12.10	10.30	5.00	2.70	1.70	3.95	2.30	0.90	0.95	2.60
2	2.75	6.30	12.20	10.20	4.50	2.80	1.70	3.00	2.40	.90	.95	2.00
3	2.75	7.50	12.30	10.00	4.20	2.80	1.65	2.30	2.80	.90	.95	1.60
4	2.80	7.40	12.10	9.80	3.95	2.60	1.60	2.00	2.40	.90	.95	1.50
5	2.80	9.10	10.10	8.90	3.80	2.30	1.50	1.90	2.10	.90	.95	1.45
6	3.00	12.10	9.00	8.75	3.75	2.10	1.50	1.75	2.00	.90	.95	1.40
7	3.50	14.10	8.00	9.00	3.60	2.00	1.45	1.65	1.85	.90	.95	1.35
8	4.30	14.30	7.50	10.00	4.00	2.00	1.40	1.50	1.40	.90	.95	1.30
9	4.20	14.30	7.25	12.30	3.85	1.95	1.70	1.50	1.30	.95	.95	1.30
10	4.40	14.10	7.00	12.00	3.60	1.95	1.60	1.55	1.25	1.20	.95	1.35
11	5.20	13.80	6.15	11.70	3.45	1.95	1.50	1.55	1.25	1.30	.95	1.40
12	5.90	13.00	5.20	10.00	3.30	1.95	1.50	1.60	2.20	1.40	.95	5.80
13	5.60	12.00	5.50	8.90	3.20	2.00	1.40	1.50	2.50	1.30	.95	8.25
14	5.00	10.90	7.50	7.90	3.00	2.15	1.40	1.45	2.65	1.20	1.00	8.00
15	4.70	8.70	8.30	6.30	3.00	2.80	1.30	1.50	2.00	1.20	1.00	6.00
16	4.90	7.90	16.00	5.55	2.95	3.20	1.30	1.50	1.40	1.20	1.00	4.50
17	5.00	7.60	17.40	5.25	2.95	2.95	1.30	1.50	1.25	1.10	1.00	3.75
18	4.90	7.80	17.00	5.10	2.80	2.50	1.20	1.55	1.20	1.00	1.00	3.60
19	4.70	8.10	16.50	5.00	2.80	2.25	1.30	1.50	1.20	.95	1.00	3.40
20	4.60	8.20	16.30	4.80	2.75	2.00	1.50	1.45	1.10	.95	1.00	3.00
21	4.20	8.00	16.35	4.60	2.75	1.80	1.50	1.45	1.00	.90	.95	2.85
22	4.00	7.65	16.20	4.30	2.70	1.70	1.90	1.35	.95	.90	.95	2.75
23	3.90	8.00	15.90	4.75	2.70	1.70	3.20	1.30	1.00	.95	.95	3.00
24	3.90	8.10	15.70	5.65	2.65	1.60	4.70	1.30	1.00	1.20	.95	5.40
25	4.00	7.30	15.50	8.90	2.60	1.75	3.60	1.30	1.00	1.15	1.00	6.40
26	4.25	7.00	14.90	9.00	2.50	1.60	3.20	1.60	1.00	1.00	2.15	7.10
27	4.15	8.30	13.25	8.90	2.45	1.60	3.00	1.20	.95	1.00	2.90	7.00
28	4.00	11.00	11.00	8.30	2.35	1.65	3.60	1.10	.95	.95	3.00	6.60
29	3.90	......	8.00	6.90	2.30	1.70	4.20	1.50	.90	.95	3.00	6.00
30	3.75	......	7.90	5.45	2.20	1.65	5.20	2.10	.90	.90	2.75	4.85
31	3.70	......	8.50	......	2.70	.....	4.75	2.10	......	.95	......	4.00

Rating table for Coosa river at Riverside, Ala., for 1899.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second ft.*	*Feet.*	*Second feet.*	*Feet.*	*Second feet.*	*Feet.*	*Second feet*
0.9	2,330	5.2	14,740	9.5	30,650	13.8	46,560
1.0	2,460	5.3	15,110	9.6	31,020	13.9	46,930
1.1	2,600	5.4	15,480	9.7	31,390	14.0	47,300
1.2	2,760	5.5	15,850	9.8	31,760	14.1	47,670
1.3	2,920	5.6	16,220	9.9	32,130	14.2	48,040
1.4	3,100	5.7	16,590	10.0	32,500	14.3	48,410
1.5	3,300	5.8	16,960	10.1	32,870	14.4	48,780
1.6	3,500	5.9	17,330	10.2	33,240	14.5	49,150
1.7	3,720	6.0	17,700	10.3	33,610	14.6	49,520
1.8	3,940	6.1	18,070	10.4	33,980	14.7	49,890
1.9	4,160	6.2	18,440	10.5	34,350	14.8	50,260
2.0	4,400	6.3	18,810	10.6	34,720	14.9	50,630
2.1	4,600	6.4	19,180	10.7	35,090	15.0	51,000
2.2	4,900	6.5	19,550	10.8	35,460	15.1	51,370
2.3	5,160	6.6	19,920	10.9	35,830	15.2	51,740
2.4	5,430	6.7	20,290	11.0	36,200	15.3	52,110
2.5	5,700	6.8	20,660	11.1	36,570	15.4	52,480
2.6	5,970	6.9	21,030	11.2	36,940	15.5	52,850
2.7	6,250	7.0	21,400	11.3	37,310	15.6	53,220
2.8	6,530	7.1	21,770	11.4	37,680	15.7	53,590
2.9	6,810	7.2	22,140	11.5	38,050	15.8	53,960
3.0	7,100	7.3	22,510	11.6	38,420	15.9	54,330
3.1	7,400	7.4	22,880	11.7	38,790	16.0	54,700
3.2	7,700	7.5	23,250	11.8	39,160	16.1	55,070
3.3	8,010	7.6	23,620	11.9	39,530	16.2	55,440
3.4	8,330	7.7	23,990	12.0	39,900	16.3	55,810
3.5	8,650	7.8	24,360	12.1	40,270	16.4	56,280
3.6	8,970	7.9	24,730	12.2	40,640	16.5	56,650
3.7	9,290	8.0	25,100	12.3	41,010	16.6	57,020
3.8	9,620	8.1	25,470	12.4	41,380	16.7	57,390
3.9	9,950	8.2	25,840	12.5	41,750	16.8	57,760
4.0	10,300	8.3	26,210	12.6	42,120	16.9	58,130
4.1	10,670	8.4	26,580	12.7	42,490	17.0	58,400
4.2	11,040	8.5	26,950	12.8	42,860	17.1	58,770
4.3	11,410	8.6	27,320	12.9	43,230	17.2	59,140
4.4	11,780	8.7	27,690	13.0	43,600	17.3	59,510
4.5	12,150	8.8	28,060	13.1	43,970	17.4	59,880
4.6	12,520	8.9	28,430	13.2	44,340	17.5	60,250
4.7	12,890	9.0	28,800	13.3	44,710	17.6	60,620
4.8	13,260	9.1	29,170	13.4	45,080	17.7	60,990
4.9	13,630	9.2	29,540	13.5	45,450	17.8	61,360
5.0	14,000	9.3	29,910	13.6	45,720	17.9	61,730
5.1	14,370	9.4	30,280	13.7	46,190	18.0	62,100

NOTE.—This table applied to the foregoing "Daily gage heights" gives the cubic feet per second flowing in the river on each date for which the gage height is given.

The following discharge measurements were made during 1900 by Max Hall and others:

February 10: Gage height, 5.03 feet; discharge, 13,493 second-feet.

March 21: Gage height, 12.50 feet; discharge, 43,759 second-feet.

May 5: Gage height, 4.15 feet; discharge, 11,196 second-feet.

August 21: Gage height, 2.32 feet; discharge, 5,609 second-feet.

December 28: Gage height, 4.25 feet; discharge, 11,335 second-feet.

Daily gage height, in feet, of Coosa River, near Riverside, Ala., for 1900.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.50	2.70	6.90	6.65	5.00	2.75	11.60	4.70	1.85	1.55	2.30	5.75
2	3.00	2.65	7.55	6.25	5.30	2.80	10.10	3.90	2.00	1.55	2.25	4.35
3	2.50	2.60	6.90	6.00	5.30	2.90	8.90	3.00	2.20	1.50	2.50	3.75
4	2.40	2.50	6.25	5.60	4.75	2.60	8.20	2.75	2.10	1.50	2.50	3.40
5	2.15	2.60	5.40	5.10	4.30	2.70	7.50	2.55	2.00	1.50	2.50	3.30
6	2.05	2.80	5.00	4.90	4.20	3.45	6.45	2.40	1.80	1.45	2.40	4.35
7	1.95	2.95	4.90	4.75	4.00	3.90	5.50	2.25	1.70	1.40	2.40	6.05
8	1.95	3.00	6.00	4.40	3.65	4.20	4.70	2.15	1.60	1.50	2.35	5.40
9	2.00	3.75	8.75	4.35	3.40	7.05	5.00	2.10	1.50	2.20	2.30	4.80
10	2.00	4.25	10.00	4.30	3.30	8.30	4.30	2.00	1.45	2.35	2.30	4.00
11	2.10	5.80	10.55	6.50	3.15	8.00	4.20	2.00	1.35	3.85	2.15	3.60
12	3.50	6.50	10.05	12.40	2.95	7.70	4.10	1.90	1.30	3.60	2.10	3.15
13	6.00	13.30	8.75	12.90	2.70	6.70	5.65	2.25	1.25	3.80	2.10	2.95
14	7.40	15.30	7.50	11.70	2.70	4.30	4.65	2.00	1.20	2.80	2.00	2.80
15	7.00	15.20	5.60	9.50	2.65	4.50	3.75	1.30	3.35	3.00	1.90	2.70
16	6.40	14.50	6.00	7.20	2.65	4.70	3.60	1.85	6.00	2.90	1.80	2.65
17	5.10	14.00	6.30	12.40	2.60	5.00	3.50	2.00	7.00	2.80	1.75	2.60
18	4.00	13.25	6.00	18.10	2.60	4.90	3.35	2.00	7.50	2.65	1.70	2.55
19	4.25	12.80	6.50	17.55	2.60	6.90	3.10	2.20	6.00	2.50	1.80	2.55
20	8.00	12.10	10.00	15.65	2.60	6.90	3.00	2.10	4.35	2.40	2.00	3.00
21	9.70	9.00	12.20	13.95	2.65	6.45	2.90	2.20	3.20	2.30	2.50	3.30
22	10.00	7.80	12.85	13.15	3.20	6.10	2.70	2.05	2.50	2.20	4.00	5.20
23	9.40	6.80	12.60	12.65	2.90	7.00	2.45	2.00	2.00	2.15	3.80	7.00
24	8.75	7.20	11.80	12.20	3.00	11.35	2.50	1.95	1.90	3.00	3.20	7.30
25	7.75	6.90	10.60	10.80	3.25	12.50	2.60	1.90	1.85	5.25	3.10	5.90
26	6.00	6.50	10.30	9.15	3.10	11.10	2.50	2.20	1.80	7.50	3.00	6.35
27	4.10	5.25	10.20	7.90	3.20	[illegible]	2.60	2.10	1.80	5.00	4.35	5.90
28	3.60	5.00	9.85	6.50	3.00	14.60	3.70	2.00	1.65	3.80	6.40	4.90
29	3.30	......	9.50	5.70	2.80	[illegible]	5.70	1.95	1.60	3.00	9.20	4.30
30	3.00	......	8.50	5.35	2.70	[illegible]	5.30	1.90	1.55	2.65	8.20	4.00
31	2.70	......	7.20	......	2.60	.	5.90	1.90	......	2.50	......	6.50

The following discharge measurements were made during 1901 by Max Hall and others:

January 8: Gage height, 3.85 feet; discharge, 9,572 second-feet.
March 18: Gage height, 3.70 feet; discharge, 9,333 second-feet.
August 24: Gage height, 12.95 feet ;discharge, 44,554 second-feet.
November 14: Gage height, 1.70 feet; discharge, 4,039 second-feet.

Daily gage height, in feet, of Coosa River, at Riverside, Ala., for 1901.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.
1..........	7.30	6.00	3.55	14.35	4.80	5.20	3.00	2.15	5.60	2.70	1.90	1.85
2..........	7.35	6.50	3.50	14.40	4.60	8.20	2.90	2.10	5.00	4.00	1.85	1.90
3..........	6.50	9.00	3.50	13.30	4.30	8.25	2.85	2.10	4.50	3.20	1.85	1.95
4..........	6.00	10.60	3.50	11.90	4.15	7.20	2.80	2.05	4.30	3.00	1.85	1.95
5..........	5.50	11.00	3.40	10.40	4.00	5.75	2.80	2.00	3.65	2.90	1.80	2.20
6..........	5.00	12.00	3.30	10.30	3.95	5.00	2.75	2.20	3.30	2.75	1.80	2.10
7..........	4.25	11.90	3.20	9.00	3.90	4.80	2.75	4.10	3.05	2.60	1.80	2.00
8..........	3.95	11.50	3.10	7.25	3.75	4.30	2.70	4.80	3.00	2.50	1.85	2.00
9..........	3.70	9.90	3.10	6.50	3.60	4.20	3.50	4.25	2.90	2.30	1.85	2.10
10..........	3.60	9.60	3.40	5.60	3.45	6.20	4.00	3.50	2.85	2.30	1.80	2.10
11..........	6.50	9.90	5.50	5.00	3.25	6.00	3.50	2.90	2.75	2.25	1.80	2.05
12..........	14.10	9.60	6.50	4.80	3.15	5.00	2.90	2.75	2.70	2.30	1.80	2.00
13..........	15.70	8.90	7.50	4.80	3.10	4.25	2.50	2.60	2.65	3.00	1.80	2.00
14..........	15.40	7.60	7.00	6.50	3.10	3.75	2.40	3.20	2.65	2.80	1.75	2.90
15..........	15.10	6.50	6.30	7.50	3.00	3.75	2.35	3.20	2.60	2.70	1.75	11.50
16..........	14.90	5.80	5.25	8.30	2.95	3.80	2.20	3.40	2.85	2.50	1.80	12.00
17..........	14.30	5.45	4.25	7.80	2.95	3.80	3.15	5.30	3.90	2.45	1.80	12.50
18..........	13.90	5.00	3.75	6.50	2.90	4.90	2.90	9.60	5.60	2.60	1.90	12.40
19..........	13.30	4.80	3.55	10.50	2.90	5.00	2.90	9.65	6.30	2.40	1.80	11.00
20..........	11.30	4.60	3.55	14.00	2.85	4.50	3.20	10.00	7.50	2.35	1.75	10.20
21..........	8.30	4.35	3.75	14.50	4.00	3.90	3.00	11.50	7.20	2.30	1.75	9.20
22..........	6.25	4.20	3.70	14.30	8.20	3.60	2.95	11.00	6.00	2.30	1.75	8.00
23..........	5.30	4.00	7.50	13.50	9.90	3.50	2.90	11.50	4.50	2.25	1.75	4.50
24..........	4.60	3.90	4.30	12.50	10.75	3.25	2.75	12.50	3.30	2.20	1.85	3.60
25..........	5.30	3.85	13.90	11.30	11.85	3.15	2.70	12.90	3.00	2.10	1.90	4.10
26..........	5.80	3.65	15.90	9.90	11.90	3.00	2.60	12.40	2.70	2.10	2.10	4.60
27..........	6.30	3.65	15.20	7.90	11.80	2.90	2.40	12.00	2.60	2.10	2.00	5.10
28..........	6.40	3.60	14.70	6.80	11.00	3.00	2.20	11.50	2.50	2.05	2.00	6.50
29..........	5.85	.....	14.25	5.90	9.60	2.90	2.30	9.95	2.65	2.05	1.85	11.50
30..........	5.50	.....	14.60	5.20	6.20	3.10	2.40	8.35	2.60	2.00	1.85	15.60
31..........	5.80	......	15.50	......	4.60	....	2.20	6.85	......	1.95	......	16.00

Rating table for Coosa River at Riverside, Ala., for 1900 and 1901.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-ft.*	*Feet.*	*Second-ft.*	*Feet.*	*Second-ft.*	*Feet.*	*Second-ft.*
1.0	2,460	5.6	15,900	10.2	33,900	14.8	52,300
1.1	2,610	5.7	16,250	10.3	34,300	14.9	52,700
1.2	2,760	5.8	16,600	10.4	34,700	15.0	53,100
1.3	2,930	5.9	16,950	10.5	35,100	15.1	53,500
1.4	3,100	6.0	17,300	10.6	35,500	15.2	53,900
1.5	3,300	6.1	17,680	10.7	35,900	15.3	54,300
1.6	3,500	6.2	18,060	10.8	36,300	15.4	54,700
1.7	3,720	6.3	18,440	10.9	36,700	15.5	55,100
1.8	3,940	6.4	18,820	11.0	37,100	15.6	55,500
1.9	4,170	6.5	19,200	11.1	37,500	15.7	55,900
2.0	4,400	6.6	19,580	11.2	37,900	15.8	56,300
2.1	4,650	6.7	19,960	11.3	38,300	15.9	56,700
2.2	4,900	6.8	20,340	11.4	38,700	16.0	57,100
2.3	5,165	6.9	20,720	11.5	39,100	16.1	57,500
2.4	5,430	7.0	21,100	11.6	39,500	16.2	57,900
2.5	5,700	7.1	21,500	11.7	39,900	16.3	58,300
2.6	5,970	7.2	21,900	11.8	40,300	16.4	58,700
2.7	6,250	7.3	22,300	11.9	40,700	16.5	59,100
2.8	6,530	7.4	22,700	12.0	41,100	16.6	59,500
2.9	6,845	7.5	23,100	12.1	41,500	16.7	59,900
3.0	7,100	7.6	23,500	12.2	41,900	16.8	60,300
3.1	7,400	7.7	23,900	12.3	42,300	16.9	60,700
3.2	7,700	7.8	24,300	12.4	42,700	17.0	61,100
3.3	8,015	7.9	24,700	12.5	43,100	17.1	61,500
3.4	8,330	8.0	25,100	12.6	43,500	17.2	61,900
3.5	8,650	8.1	25,500	12.7	43,900	17.3	62,300
3.6	8,970	8.2	25,900	12.8	44,300	17.4	62,700
3.7	9,295	8.3	26,300	12.9	44,700	17.5	63,100
3.8	9,620	8.4	26,700	13.0	45,100	17.6	63,500
3.9	9,960	8.5	27,100	13.1	45,500	17.7	63,900
4.0	10,300	8.6	27,500	13.2	45,900	17.8	64,300
4.1	10,650	8.7	27,900	13.3	46,300	17.9	64,700
4.2	11,000	8.8	28,300	13.4	46,700	18.0	65,100
4.3	11,350	8.9	28,700	13.5	47,100	18.1	65,500
4.4	11,700	9.0	29,100	13.6	47,500	18.2	65,900
4.5	12,050	9.1	29,500	13.7	47,900	18.3	66,300
4.6	12,400	9.2	29,900	13.8	48,300	18.4	66,700
4.7	12,750	9.3	30,300	13.9	48,700	18.5	67,100
4.8	13,100	9.4	30,700	14.0	49,100	18.6	67,500
4.9	13,450	9.5	31,100	14.1	49,500	18.7	67,900
5.0	13,800	9.6	31,500	14.2	49,900	18.8	68,300
5.1	14,150	9.7	31,900	14.3	50,300	18.9	68,700
5.2	14,500	9.8	32,300	14.4	50,700	19.0	69,100
5.3	14,850	9.9	32,700	14.5	51,100		
5.4	15,200	10.0	33,100	14.6	51,500		
5.5	15,550	10.1	33,500	14.7	51,900		

NOTE.—This table applied to the foregoing "Daily gage heights" gives the cubic feet per second flowing in the river on each date for which the gage height is given.

Estimated monthly discharge of Coosa River at Riverside, Ala.

[Drainage area, 6,850 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Depth in inches.	Second-feet per square mile.
1896.						
September 27 to 30	1,400	1,350	1,363	10,812	0.03	0.20
October	7,640	1,450	2,218	136,380	0.37	0.32
November	15,100	2,190	4,637	275,921	0.75	0.68
December	12,110	2,280	4,125	253,636	0.69	0.60
1897.						
January	21,707	2,420	8,434	518,590	1.42	1.23
February	27,086	4,520	18,658	1,036,230	2.83	2.72
March	47,624	10,460	32,481	1,997,180	5.47	4.74
April	37,355	5,100	17,698	1,053,105	2.87	2.58
May	10,786	4,270	7,040	432,875	1.19	1.03
June	4,950	3,070	3,915	232,960	0.63	0.57
July	23,826	3,070	7,142	439,145	1.20	1.04
August	6,300	2,850	3,870	237,960	0.64	0.56
September	3,540	1,440	1,976	117,580	0.32	0.29
October	3,660	1,350	1,819	111,845	0.31	0.27
November	2,525	1,570	1,786	106,275	0.29	0.26
December	13,883	1,820	6,566	403,730	1.10	0.96
1898.						
January	35,084	3,550	11,572	711,539	1.95	1.69
February	16,760	3,655	5,763	320,161	0.87	0.84
March	15,045	3,550	5,852	359,828	0.68	0.59
April	36,160	8,260	18,133	1,078,986	2.95	2.65
May	9,560	3,028	4,684	288,010	0.78	0.68
June	5,540	2,320	3,281	195,233	0.54	0.48
July	9,900	2,140	4,289	263,722	0.72	0.63
August	19,161	3,970	8,758	538,512	1.48	1.28
September	41,920	3,865	13,927	828,712	2.26	2.03
October	72,160	3,760	19,936	1,225,825	3.36	2.91
November	20,190	5,300	8,375	498,345	1.36	1.22
December	9,900	5,070	7,376	453,535	1.25	1.08
1899.						
January	17,330	6,390	10,865	668,063	1.78	1.54
February	48,410	17,330	30,974	1,720,209	4.56	4.38
March	60,880	14,740	38,094	2,342,309	6.21	5.39
April	41,010	11,410	24,915	1,482,545	3.94	3.53
May	14,000	4,900	7,742	476,037	1.27	1.10
June	7,700	3,500	4,771	283,894	0.75	0.68
July	14,740	2,760	5,318	326,991	0.86	0.75
August	10,125	2,600	3,806	234,022	0.62	0.54
September	6,530	2,330	3,555	211,537	0.56	0.50
October	3,100	2,330	2,510	154,334	0.41	0.36
November	7,100	2,395	3,086	183,630	0.49	0.44
December	26,025	2,920	10,631	653,675	1.73	1.50

Estimated monthly discharge of Coosa River near Riverside, Ala.

[Drainage area, 7,065 square miles.]

Month	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Total in acre-feet.	Depth in inches.	Second feet per square mile.
1900.						
January	33,100	4,280	13,344	820,491	2.18	1.89
February	54,300	5,700	23,487	1,304,402	3.45	3.32
March	44,500	13,450	26,822	1,649,221	4.38	3.80
April	65,500	11,350	29,813	1,773,997	4.71	4.22
May	14,850	5,970	8,198	504,075	1.34	1.16
June	51,500	5,970	22,216	1,321,944	3.51	3.14
July	39,500	5,565	13,610	836,846	2.23	1.93
August	12,750	4,050	5,147	316,477	0.84	0.73
September	23,100	2,760	6,483	385,765	1.03	0.92
October	23,100	3,100	6,910	424,879	1.13	0.98
November	29,900	3,720	7,673	456,575	1.22	1.09
December	22,300	5,835	11,773	723,894	1.93	1.67
The year	65,500	2,760	14,623	10518566	27.95	2.07

Month.	Discharge in second-feet			Run-off.	
	Maximum.	Minimum.	Mean.	Depth in inches.	Second feet per square mile.
1901.					
January	55,900	8,970	26,089	4.25	3.69
February	41,100	8,970	21,784	3.21	3.08
March	56,700	7,400	20,613	3.37	2.92
April	51,100	14,500	30,616	4.83	4.33
May	40,700	6,670	16,195	2.64	2.29
June	26,100	6,810	12,335	1.95	1.75
July	10,300	4,900	6,535	1.07	0.93
August	44,700	4,400	20,370	3.32	2.88
September	23,100	5,700	9,977	1.57	1.41
October	10,300	4,280	5,694	0.93	0.81
November	4,650	3,830	4,016	0.64	0.57
December	57,100	4,050	18,885	3.08	2.67
The year	57,100	3,830	16,092	30.86	2.28

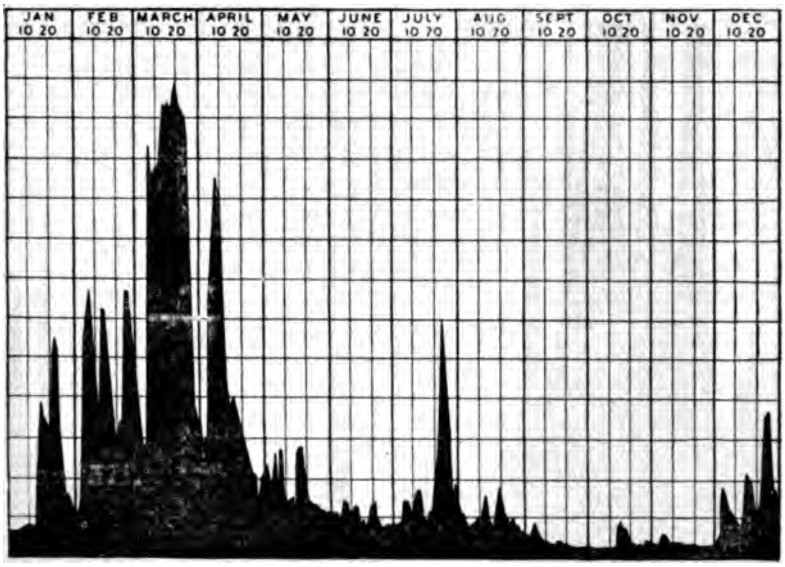

Fig. 9.—Discharge of Coosa River at Riverside, Ala., 1897.

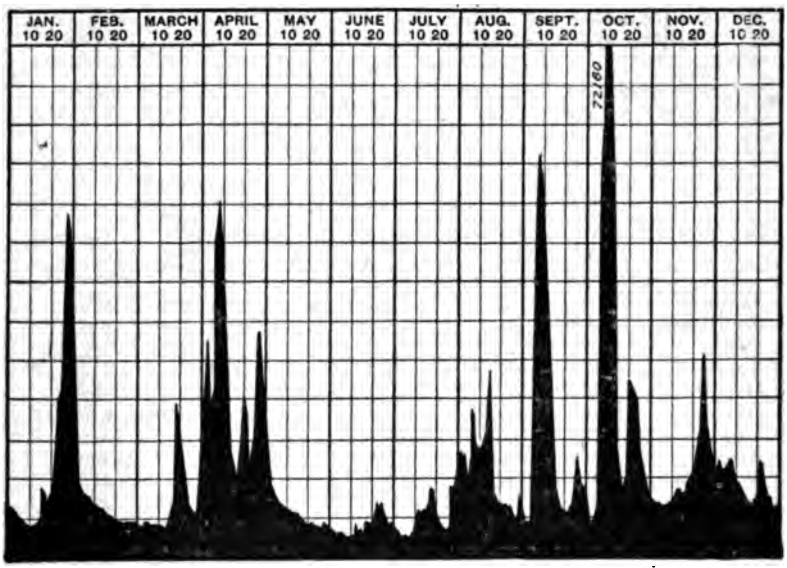

Fig. 10.—Discharge of Coosa River at Riverside, Ala., 1898.

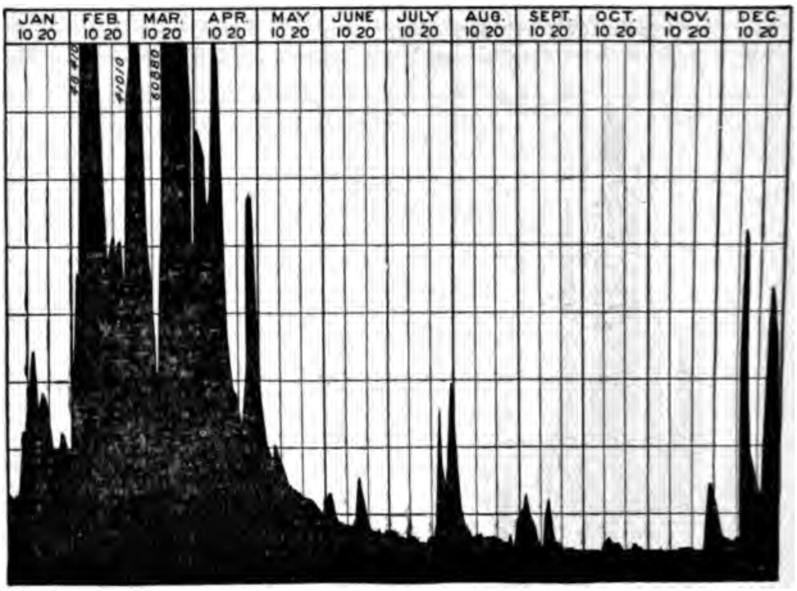

Fig. 11.—Discharge of Coosa River at Riverside, Ala., 1899.

Minimum monthly discharge of Coosa River at Riverside, Ala., with corresponding net horsepower per foot of fall on a water wheel realizing 80 per cent of theoretical power.

[Drainage area, 6,850 square miles.]

	1899			1900			1901		
	Minimum cubic feet per second.	Minimum net H. P. per foot of fall.	No. of days duration of minimum.	Minimum cubic feet per second.	Minimum net H. P. per foot of fall.	No. of days duration of minimum.	Minimum cubic feet per second.	Minimum net H. P. per foot of fall.	No. of days duration of minimum.
January ..	6,390	581	2	4,285	390	2	8,970	815	1
February .	17,330	1,575	1	5,700	518	1	8,970	815	1
March ...	14,740	1,340	1	13,450	1,223	1	7,400	673	2
April	11,410	1,037	1	11,350	1,032	1	14,500	1,310	2
May	4,900	445	1	5,970	543	5	6,687	608	1
June	3,500	318	3	5,970	543	1	6,810	619	2
July	2,760	251	1	5,565	506	1	4,900	445	3
August	2,600	236	1	4,050	369	1	4,400	400	1
September	2,330	212	2	2,760	251	1	5,700	518	1
October ...	2,330	212	11	3,100	282	1	4,285	390	1
November .	2,395	218	17	3,720	338	1	3,830	348	6
December .	2,920	265	2	5,835	530	2	4,050	368	1

NOTE.—To find the minimum net horse power available at a shoal on this stream, near this station, for any month, multiply the total fall of the shoal by the "Net H. P. per foot of fall" in this table that month.

2. COOSA RIVER AT ROME, GEORGIA.

Coosa River is formed by the junction of Etowah and Oostanaula rivers at Rome, Ga. The drainage area is 4,006 square miles. Both of the tributary rivers rise in the northern part of Georgia and flow for the most part through a hilly, broken country, well wooded, about one-fourth of the land being under cultivation. The Coosa River flows in a southwesterly direction into Alabama and joins the Tallapoosa 6 miles above Montgomery, Ala., to form Alabama River. Measurements of flow are made at Rome and at Riverside, 120 miles farther downstream. The measurements at Rome are made on the Oostanaula and Etowah just above their junction. Etowah River is measured at Second avenue bridge and the Oostanaula at Fifth avenue bridge in Rome, and the result added to give the flow of Coosa River. The gage height is taken from the United States Weather Bureau gage at Fifth avenue bridge, on the Oostanaula. There is practically no fall on Oostanaula River from Fifth avenue bridge to the junction, hence the gage is used as Coosa River gage and gives the fluctuations of Coosa River. This gage is a 4 by 6 inch timber, graduated to feet and tenths and fastened to the downstream left-hand corner of the first pier from the left bank. The zero of gage is 575.79 feet avove sea level. The United States Weather Bureau has maintained the station here for many years. It is now maintained only as a half-year station, from November 1 to April 30, inclusive, but W. M. Towers, the river observer, kindly reads the gage and furnishes the Survey with monthly reports of the daily gage heights for the entire year without charge. Mr. Towers has kept the records for many years and has predicted floods with great precision. The channel of the Etowah is straight, current swift and unobstructed, but the Oostanaula is rather sluggish and somewhat obstructed by piers. The banks are high, but liable to overflow in times of high water.

The following discharge measurements were made during 1896-97-98 by Max Hall and others:

1896—
September 29: Gage height, 0.20 feet; discharge, 1,209 second-feet.
1897—
May 7: Gage height, 2.75 feet; discharge, 4,646 second-feet.
October 5: Gage height, 0.15 feet; discharge, 990 second-feet.

1898—

May 11: Gage height, 1.90 feet; discharge, 2,946 second-feet.

September 17: Gage height, 2.60 feet; discharge, 3,913 second-feet.

October 11: Gage height, 5.05 feet; discharge, 8,324 second-feet.

October 22: Gage height, 4.10 feet; discharge, 6,489 second-feet.

November 30: Gage height, 3.90 feet; discharge, 6,039 second-feet.

Daily gage height, in feet, of Coosa River at Rome, Ga., for 1897...

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.0	2.8	3.3	7.1	4.1	1.8	1.7	0.8	1.0	0.0	0.5	1.1
2	1.0	9.7	3.2	7.5	4.0	2.3	1.9	.7	.5	0.0	.9	1.0
3	1.0	11.5	3.1	8.2	3.5	2.0	1.0	1.2	.3	0.0	1.0	1.2
4	1.0	9.6	3.3	9.4	3.3	3.0	0.9	1.0	.5	.1	1.0	2.3
5	1.0	8.2	3.5	14.8	3.0	2.4	2.0	.8	.4	.1	1.0	3.2
6	1.3	5.2	7.6	18.9	3.0	2.0	1.9	.8	.3	.1	.8	3.7
7	1.1	5.0	19.7	17.0	3.0	2.0	1.9	1.9	.3	.1	.8	3.2
8	1.1	4.3	18.9	14.7	2.8	2.0	3.0	2.0	.2	.1	.8	2.2
9	1.0	5.0	15.4	12.1	2.6	2.0	2.1	2.0	.1	.1	.8	1.9
10	1.0	4.4	13.5	9.6	2.6	1.9	1.9	1.6	.0	.1	.7	1.7
11	.9	4.5	12.0	7.2	2.6	1.9	2.5	2.4	.0	.1	.7	1.5
12	.9	7.4	11.5	6.2	3.0	1.9	2.8	1.8	.0	1.1	.7	1.4
13	.9	8.7	18.6	5.8	3.4	1.8	2.0	1.3	.0	1.6	.7	1.3
14	2.8	7.2	21.3	5.0	4.0	1.7	1.6	.8	.0	1.3	.6	2.3
15	6.2	5.5	23.8	6.0	5.0	1.7	1.3	.6	.0	1.0	.0	4.0
16	5.0	4.5	23.4	7.4	4.0	2.0	1.0	.6	.0	.8	.6	3.5
17	3.5	4.0	22.6	7.0	3.3	2.8	5.2	2.1	.0	.7	.6	2.5
18	3.9	3.7	21.4	5.0	2.8	2.3	4.2	3.2	.1	.6	.6	2.2
19	5.0	3.4	19.7	4.5	2.7	2.0	4.8	2.4	.2	.6	.6	1.8
20	3.5	3.0	18.9	4.0	2.6	1.8	8.8	1.4	.2	.6	.5	1.7
21	8.7	4.0	17.7	3.[illegible]	2.5	1.6	12.8	1.3	.2	1.5	.6	3.2
22	9.5	3.9	15.3	3.7	2.4	1.5	7.3	1.5	.2	1.3	.5	4.1
23	5.7	5.6	13.7	3.5	2.4	1.5	4.4	1.5	.2	1.0	.5	5.8
24	4.0	11.7	12.9	3.5	2.4	1.4	3.9	1.5	.2	.8	.5	5.3
25	3.5	8.6	9.1	3.5	2.3	1.3	2.6	1.1	.3	.8	.5	3.7
26	3.0	6.7	6.0	3.5	2.2	1.2	2.6	.8	.3	.7	.5	2.8
27	2.5	4.7	5.2	3.4	2.1	1.2	3.8	.5	.4	.7	.5	3.0
28	2.5	3.5	4.8	3.4	2.0	1.0	3.0	.4	.4	.7	.9	2.8
29	2.5	......	4.5	3.4	2.0	1.1	2.4	.4	.4	.6	1.1	2.3
30	2.3	......	4.2	3.2	1.9	2.0	1.4	.4	.4	.5	1.1	2.0
31	2.2	......	4.0	......	1.9	...	1.2	.5	......	.5	......	2.0

Daily gage height in feet, of Coosa River, at Rome, Ga., for 1898.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.
1..........	1.8	3.6	1.2	9.0	2.8	1.4	1.2	4.8	2.0	2.0	2.2	4.2
2..........	1.8	3.1	1.2	6.1	2.6	1.4	1.0	4.4	7.8	2.0	2.2	4.0
3..........	1.7	2.8	1.2	4.2	2.4	1.4	1.0	3.2	21.7	2.0	2.2	3.8
4..........	1.7	2.6	1.2	3.6	2.3	1.4	1.0	4.4	24.3	4.9	2.2	3.8
5..........	1.6	2.4	1.2	9.9	2.2	1.3	1.0	8.0	22.2	22.0	2.0	4.3
6..........	1.6	2.2	1.2	17.2	2.1	1.3	1.3	5.6	20.0	23.8	2.2	5.0
7..........	1.3	2.0	1.2	14.5	2.0	1.3	2.0	4.4	17.6	19.0	2.6	4.3
8..........	1.3	1.8	1.2	10.9	2.0	1.3	2.8	4.4	16.4	18.4	2.4	4.0
9..........	1.3	1.8	1.2	7.0	2.0	1.3	3.2	3.4	9.7	16.6	2.3	3.7
10..........	1.3	1.7	1.2	4.1	2.0	1.3	1.7	3.0	5.0	14.0	2.1	3.4
11..........	1.4	1.5	1.2	4.0	2.0	1.3	2.8	9.9	5.4	5.6	2.0	3.3
12..........	2.0	1.5	1.2	3.8	1.9	1.2	2.0	7.2	4.6	4.2	2.0	3.3
13..........	1.0	1.3	1.2	3.6	1.8	1.4	1.8	4.2	3.8	3.8	2.0	3.2
14..........	4.0	1.3	1.3	3.5	1.8	1.8	1.6	3.4	3.2	3.7	2.3	3.0
15..........	3.8	1.3	1.6	3.5	1.7	1.8	3.7	3.0	3.0	3.5	2.3	3.0
16..........	3.6	1.3	3.7	3.4	1.6	1.7	3.7	2.5	2.9	3.2	2.9	2.8
17..........	3.6	1.2	7.3	3.0	1.5	1.8	2.2	2.0	2.7	3.1	2.9	2.7
18..........	3.2	1.2	5.8	3.0	1.5	1.8	1.9	2.2	2.5	6.5	4.0	2.6
19..........	2.8	1.2	3.7	3.0	1.5	2.2	1.7	2.2	2.3	9.0	5.0	2.6
20..........	4.4	1.2	3.0	3.6	1.4	3.6	1.6	3.2	2.2	6.0	4.5	2.6
21..........	6.5	1.2	2.5	3.6	1.4	3.2	1.5	2.8	2.2	4.2	5.0	2.8
22..........	6.4	1.2	2.5	3.2	1.4	3.0	1.4	3.9	2.3	3.9	4.0	2.9
23	5.0	1.2	2.3	3.0	1.4	2.8	1.3	2.2	2.6	4.0	5.0	3.2
24	4.5	1.2	2.2	7.2	1.4	2.6	1.8	2.2	4.1	3.9	7.0	3.6
25..........	7.0	1.2	2.1	8.2	1.4	2.0	3.7	1.9	3.1	3.5	4.7	3.0
26..........	14.0	1.2	2.0	6.0	1.4	1.8	3.8	2.7	3.0	3.3	3.9	2.9
27..........	14.6	1.2	1.9	4.6	1.4	1.8	2.9	4.0	2.7	3.1	4.5	2.7
28	11.6	1.2	1.8	4.0	1.4	1.8	3.7	4.4	2.5	3.0	4.3	2.6
29..........	8.6	......	2.0	3.7	1.4	1.6	4.2	3.4	2.3	2.8	4.3	2.5
30..........	4.6	......	8.5	3.2	1.4	1.4	4.1	2.0	2.1	2.6	3.9	2.4
31..........	3.9	......	11.4	......	1.4	...	4.2	2.3	......	2.4	......	2.4

Rating table for Coosa River at Rome, Ga., for 1897 **and** *1898.*

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second ft.*	*Feet.*	*Second ft.*	*Feet.*	*Second ft.*	*Feet.*	*Second ft.*
-0.15	990	2.5	3,760	5.1	8,445	7.7	13,515
0.0	1,070	2.6	3,910	5.2	8,640	7.8	13,710
0.1	1,140	2.7	4,060	5.3	8,835	7.9	13,905
0.2	1,210	2.8	4,220	5.4	9,030	8.0	14,100
0.3	1,280	2.9	4,380	5.5	9,225	8.1	14,295
0.4	1,360	3.0	4,540	5.6	9,420	8.2	14,490
0.5	1,440	3.1	4,700	5.7	9,615	8.3	14,685
0.6	1,520	3.2	4,860	5.8	9,810	8.4	14,880
0.7	1,610	3.3	5,020	5.9	10,005	8.5	15,075
0.8	1,700	3.4	5,180	6.0	10,200	8.6	15,270
0.9	1,800	3.5	5,340	6.1	10,395	8.7	15,465
1.0	1,900	3.6	5,520	6.2	10,590	8.8	15,660
1.1	2,000	3.7	5,715	6.3	10,785	8.9	15,855
1.2	2,110	3.8	5,910	6.4	10,980	9.0	16,050
1.3	2,220	3.9	6,105	6.5	11,175	10.0	18,000
1.4	2,330	4.0	6,300	6.6	11,370	11.0	19,950
1.5	2,450	4.1	6,495	6.7	11,565	12.0	21,900
1.6	2,570	4.2	6,690	6.8	11,760	13.0	23,850
1.7	2,690	4.3	6,885	6.9	11,955	14.0	25,800
1.8	2,810	4.4	7,080	7.0	12,150	15.0	27,750
1.9	2,930	4.5	7,275	7.1	12,345	16.0	29,700
2.0	3,060	4.6	7,470	7.2	12,540	17.0	31,650
2.1	3,190	4.7	7,665	7.3	12,735	18.0	33,600
2.2	3,320	4.8	7,860	7.4	12,930	20.0	37,500
2.3	3,460	4.9	8,055	7.5	13,125	22.0	41,400
2.4	3,610	5.0	8,250	7.6	13,320	24.0	45,300

NOTE.—This table applied to the foregoing "Daily gage heights" gives the cubic feet per second flowing in the river on each date for which the gage height is given.

The following discharge measurements were made during 1899 by Max Hall and others:

January 25—Gage height, 3.80 feet; discharge, 6,540 second-feet.
January 25—Gage height, 3.60 feet; discharge, 5,932 second-feet.
May 19—Gage height, 2.75 feet; discharge, 4,394 second-feet.
June 16—Gage height, 2.40 feet; discharge, 3,352 second-feet.
August 4—Gage height, 1.45 feet; discharge, 2,835 second-feet.
October 13—Gage height, 0.60 foot; discharge, 1,769 second-feet.

Daily gage height, in feet, of Coosa River, at Rome, Georgia, for 1899.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.
1..........	3.00	6.90	19.70	13.20	4.00	3.00	1.70	2.20	3.40	0.40	0.7	1.1
2..........	3.40	7.80	15.00	10.60	3.70	2.60	1.50	1.90	2.00	.30	.6	1.1
3..........	3.00	6.00	8.60	7.90	3.70	2.60	1.00	1.70	1.60	.30	.5	1.5
4..........	2.70	9.20	6.60	7.20	3.50	2.00	.90	1.50	1.40	.30	.5	1.3
5..........	2.60	15.30	7.80	9.50	3.50	2.00	2.00	1.40	1.30	.30	.4	1.1
6..........	2.60	18.20	9.00	8.20	3.50	2.00	1.90	1.50	1.30	.50	.4	1.0
7..........	3.60	27.80	8.00	8.20	3.70	2.00	1.90	1.60	1.20	.70	.3	.9
8..........	5.90	24.00	6.80	15.00	3.70	1.90	3.00	1.50	1.00	.70	.3	.8
9..........	5.90	22.40	5.70	13.40	3.60	1.80	2.10	1.80	1.00	.80	.3	.8
10..........	4.90	21.00	5.40	11.20	3.50	1.80	1.90	1.60	1.00	.60	.3	.8
11..........	4.00	19.00	5.20	9.50	3.30	1.80	2.50	1.40	2.90	1.00	.3	.8
12..........	4.50	16.50	4.90	7.00	3.10	2.20	2.80	1.40	2.30	.90	.3	2.8
13..........	4.00	7.00	4.50	6.40	3.10	3.80	2.00	1.20	1.50	.70	.3	6.1
14..........	3.80	5.00	6.00	5.90	3.00	4.00	1.60	1.10	1.00	.70	.4	5.0
15..........	3.60	5.00	16.60	5.60	3.00	3.50	1.30	1.30	.90	.60	.4	3.2
16..........	3.60	5.50	27.70	5.40	2.90	2.50	1.80	1.90	.80	.60	.5	2.0
17..........	4.00	8.90	29.20	5.20	2.80	2.10	5.20	1.60	.60	.60	.9	1.8
18..........	4.20	9.50	25.80	4.80	2.80	2.00	4.20	1.40	.60	.60	.7	1.7
19..........	4.00	8.50	24.90	4.70	2.80	2.00	4.80	1.10	.60	.60	.5	1.3
20..........	3.70	7.70	26.20	4.60	2.80	2.00	8.80	.90	.70	.60	.5	1.6
21..........	3.30	6.80	24.60	4.30	2.60	1.80	12.80	.30	.70	.70	.5	2.0
22..........	3.20	6.90	23.00	4.10	2.60	2.20	7.90	.80	.60	.70	.4	2.0
23..........	3.10	7.30	22.60	4.00	2.40	1.70	4.80	.80	.60	.60	1.0	1.8
24..........	3.50	6.60	21.90	5.40	2.60	1.70	3.90	.70	.50	.50	2.1	7.2
25..........	3.80	5.80	18.00	7.40	2.50	1.70	2.60	.70	.50	.40	1.5	7.5
26..........	3.80	5.50	10.50	9.10	2.40	1.70	2.60	.70	.50	.40	2.5	5.0
27..........	3.30	19.10	7.70	6.70	2.20	2.10	3.80	2.50	.50	.40	3.0	3.5
28..........	3.00	23.40	6.80	5.50	2.20	1.90	3.00	2.50	.60	.40	2.2	3.0
29..........	3.00	......	8.80	4.80	2.00	1.90	2.40	2.50	.50	.40	1.9	3.0
30..........	2.90	......	9.30	4.20	2.00	1.80	1.40	2.00	.40	.50	1.4	3.4
31..........	4.40	......	10.20	......	3.30	....	1.20	2.50	......	.80	......	2.0

Rating table for Coosa River at Rome, Georgia, for 1899.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second ft.*	*Feet.*	*Second ft.*	*Feet.*	*Second ft.*	*Feet.*	*Second ft.*
1.0	2,030	8.1	14,941	15.9	30,619	23.0	44,890
1.1	2,124	8.2	15,142	16.0	30,820	23.1	45,091
1.2	2,218	9.0	16,750	16.1	31,021	23.2	45,292
1.3	2,312	9.1	16,951	16.2	31,222	23.3	45,493
1.4	2,406	9.2	17,152	16.3	31,423	23.4	45,694
1.5	2,500	9.3	17,353	16.4	31,624	23.5	45,895
1.6	2,620	9.4	17,554	16.5	31,825	23.6	46,096
1.7	2,740	9.5	17,755	16.6	32,026	23.7	46,297
1.8	2,860	9.6	17,956	16.7	32,227	23.8	46,498
1.9	2,980	9.7	18,157	16.8	32,428	23.9	46,699
2.0	3,100	9.8	18,358	16.9	32,629	24.0	46,900
2.1	3,260	9.9	18,559	17.0	32,830	24.1	47,101
2.2	3,420	10.0	18,760	17.1	33,031	24.2	47,302
2.3	3,580	10.1	18,961	17.2	33,232	24.3	47,503
2.4	3,740	10.2	19,162	17.3	33,433	24.4	47,704
2.5	3,900	10.3	19,363	17.4	33,634	24.5	47,905
2.6	4,060	10.4	19,564	17.5	33,835	24.6	48,106
2.7	4,220	10.5	19,765	17.6	34,036	24.7	48,307
2.8	4,380	10.6	19,966	17.7	34,237	24.8	48,508
2.9	4,540	10.7	20,167	17.8	34,438	24.9	48,709
3.0	4,700	10.8	20,368	17.9	34,639	25.0	48,910
3.1	4,900	10.9	20,569	18.0	34,840	25.1	49,111
3.2	5,100	11.0	20,770	18.1	35,041	25.2	49,312
3.3	5,300	11.1	20,971	18.2	35,242	25.3	49,513
3.4	5,500	11.2	21,172	18.3	35,443	25.4	49,714
3.5	5,700	11.3	21,373	18.4	35,644	25.5	49,915
3.6	5,900	11.4	21,574	18.5	35,845	25.6	50,116
3.7	6,100	11.5	21,775	18.6	36,046	25.7	50,317
3.8	6,300	11.6	21,976	18.7	36,247	25.8	50,518
3.9	6,500	11.7	22,177	18.8	36,448	25.9	50,719
4.0	6,700	11.8	22,378	18.9	36,649	26.0	50,920
4.1	6,901	11.9	22,579	19.0	36,850	26.1	51,121
4.2	7,102	12.0	22,780	19.1	37,051	26.2	51,322
4.3	7,303	12.1	22,981	19.2	37,252	26.3	51,523
4.4	7,504	12.2	23,182	19.3	37,453	26.4	51,724
4.5	7,705	12.3	23,383	19.4	37,654	26.5	51,925
4.6	7,906	12.4	23,584	19.5	37,855	26.6	52,126
4.7	8,107	12.5	23,785	19.6	38,056	26.7	52,327
4.8	8,308	12.6	23,986	19.7	38,257	26.8	52,528
4.9	8,509	12.7	24,187	19.8	38,458	26.9	52,729
5.0	8,710	12.8	24,388	19.9	38,659	27.0	52,930
5.1	8,911	12.9	24,589	20.0	38,860	27.1	53,131
5.2	9,112	13.0	24,790	20.1	39,061	27.2	53,332
5.3	9,313	13.1	24,991	20.2	39,262	27.3	53,533
5.4	9,514	13.2	25,192	20.3	39,463	27.4	53,734

Rating table for Coosa River at Rome, Ga., for 1899.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second ft.*	*Feet.*	*Second ft.*		*Second ft.*	*Feet.*	*Second ft.*
5.5	9,715	13.3	25,393	20.4	39,664	27.5	53,935
5.6	9,916	13.4	25,594	20.5	39,865	27.6	54,136
5.7	10,117	13.5	25,795	20.6	40,066	27.7	54,337
5.8	10,318	13.6	25,996	20.7	40,267	27.8	54,538
5.9	10,519	13.7	26,197	20.8	40,468	27.9	54,739
6.0	10,720	13.8	26,398	20.9	40,669	28.0	54,940
6.1	10,921	13.9	26,599	21.0	40,870	28.1	55,141
6.2	11,122	14.0	26,800	21.1	41,071	28.2	55,342
6.3	11,323	14.1	27,001	21.2	41,272	28.3	55,543
6.4	11,524	14.2	27,202	21.3	41,473	28.4	55,744
6.5	11,725	14.3	27,403	21.4	41,674	28.5	55,945
6.6	11,926	14.4	27,604	21.5	41,875	28.6	56,146
6.7	12,127	14.5	27,805	21.6	42,076	28.7	56,347
6.8	12,328	14.6	28,006	21.7	42,277	28.8	56,548
6.9	12,529	14.7	28,207	21.8	42,478	28.9	56,749
7.0	12,730	14.8	28,408	21.9	42,679	29.0	56,950
7.1	12,931	14.9	28,609	22.0	42,880	29.1	57,151
7.2	13,132	15.0	28,810	22.1	43,081	29.2	57,352
7.3	13,333	15.1	29,011	22.2	43,282	29.3	57,553
7.4	13,534	15.2	29,212	22.3	43,483	29.4	57,754
7.5	13,735	15.3	29,413	22.4	43,684	29.5	57,955
7.6	13,936	15.4	29,614	22.5	43,885	29.6	58,156
7.7	14,137	15.5	29,815	22.6	44,086	29.7	58,357
7.8	14,338	15.6	30,016	22.7	44,287	29.8	58,558
7.9	14,539	15.7	30,217	22.8	44,488	29.9	58,759
8.0	14,740	15.8	30,418	22.9	44,689	30.0	58,960

The following discharge measurements were made during 1900 by Max Hall and others:

Feb. 21—Gage height, 4.80 feet; discharge, 8,115 second-feet.
May 19—Gage height, 2.30 feet; discharge, 4,496 second-feet.
Sept. 13—Gage height, 0.90 foot; discharge, 1,992 second-feet.
Dec. 8—Gage height, 3.73 feet; discharge, 6,066 second-feet.

Daily gage height, in feet, of Coosa River, at Rome, Georgia, for 1900.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.0	2.0	4.2	4.4	6.2	2.4	10.5	3.4	1.5	1.2	2.1	3.2
2	1.6	1.8	5.8	4.2	4.8	2.5	8.0	3.2	1.5	1.2	2.2	2.8
3	1.5	1.6	5.6	4.0	4.0	2.8	8.0	3.0	1.7	1.0	2.0	2.6
4	1.5	2.0	4.4	4.0	4.0	4.2	7.0	2.8	1.7	1.0	2.3	3.5
5	1.5	3.0	4.1	4.0	3.8	4.2	5.5	2.6	1.5	.9	2.3	7.4
6	1.5	3.8	3.8	4.0	3.7	4.2	4.2	2.5	1.5	.9	2.1	6.8
7	1.5	2.8	5.0	3.8	3.6	4.8	3.8	2.2	1.4	.9	2.1	5.2
8	1.5	2.4	8.2	3.8	3.4	13.0	3.8	2.2	1.0	3.8	2.0	3.8
9	1.5	4.0	15.0	3.6	3.0	12.6	4.0	2.0	1.0	5.9	1.9	3.6
10	1.5	6.9	13.4	3.5	3.0	8.0	4.9	2.0	.8	2.6	1.8	3.2
11	2.0	7.0	10.3	6.0	3.0	5.9	3.8	1.8	.8	2.0	1.8	2.8
12	7.0	6.4	7.5	11.0	3.0	5.0	3.4	1.8	.8	1.8	1.6	2.6
13	9.0	22.6	5.5	7.4	2.5	5.2	3.8	1.8	.8	2.5	1.5	2.6
14	7.2	27.2	4.8	5.5	2.4	5.3	3.4	1.7	.8	3.2	1.5	2.4
15	5.5	25.3	4.2	4.5	2.4	4.2	3.4	2.0	6.5	3.0	1.5	2.2
16	3.5	21.2	5.3	5.6	2.4	3.8	3.3	1.7	11.1	2.0	1.5	2.2
17	3.0	18.0	5.6	6.2	2.4	4.8	3.1	1.6	7.0	1.6	1.5	2.2
18	2.9	10.7	4.5	11.0	2.4	6.0	3.0	1.8	3.2	1.5	1.4	2.0
19	5.0	5.0	5.2	11.1	2.9	6.5	2.8	2.2	2.3	1.5	1.4	2.0
20	11.3	4.0	15.9	11.4	3.0	7.2	2.6	2.0	2.0	1.4	1.6	2.8
21	10.6	4.1	17.5	13.6	2.6	4.2	2.5	1.6	1.8	1.8	1.8	6.7
22	8.5	6.8	14.6	12.7	2.5	3.6	2.4	1.6	1.8	1.8	2.1	8.0
23	5.8	7.6	10.4	10.5	2.3	5.5	2.4	1.6	1.6	1.6	2.1	7.0
24	4.0	6.0	7.2	8.6	2.9	14.2	2.4	1.9	1.6	1.6	2.0	6.6
25	3.4	5.8	8.8	8.5	3.2	18.2	3.6	2.4	1.5	1.5	5.0	6.6
26	3.1	5.2	13.0	6.5	2.7	17.0	2.8	2.0	1.5	1.5	11.0	5.6
27	2.8	4.6	12.1	5.3	2.6	15.5	6.2	1.8	1.4	1.4	11.5	4.0
28	2.6	4.0	8.9	4.8	2.5	15.6	6.8	1.6	1.4	2.2	8.6	3.8
29	2.4	......	5.8	4.3	2.4	14.2	6.2	1.5	1.3	2.2	7.0	3.6
30	2.1	......	5.7	6.0	2.9	10.0	4.5	1.5	1.3	2.1	4.0	3.5
31	2.0	......	5.3	......	3.0	....	4.0	1.5	......	2.1	......	5.6

The following discharge measurements were made during 1901 by Max Hall and others:

Jan. 23—Gage height, 3.60 feet; discharge, 6,454 second-feet.
April 5—Gage height, 9.90 feet; discharge, 16,692 second-feet.
June 22—Gage height, 3.70 feet; discharge, 6,030 second-feet.
Oct. 15—Gage height, 3.15 feet; discharge, 5,388 second-feet.

Daily gage height of Coosa River at Rome, Georgia, for 1901.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec
1..........	7.4	6.4	3.0	8.8	4.0	10.6	3.6	1.8	6.4	2.6	1.2	1.3
2..........	6.4	5.8	3.0	8.6	3.8	7.6	3.0	1.8	5.8	2.6	1.2	1.3
3..........	5.2	5.5	3.0	13.0	3.8	5.6	3.0	1.8	3.7	3.2	1.2	1.3
4..........	4.2	15.8	3.0	13.0	3.8	6.4	2.6	1.6	3.4	3.0	1.2	1.5
5..........	4.0	18.5	3.0	10.0	3.6	5.0	2.4	1.6	3.0	2.8	1.2	2.0
6..........	3.8	13.8	3.0	7.9	3.5	4.0	2.2	2.6	2.9	2.2	1.2	1.8
7..........	3.5	9.5	3.0	6.4	3.5	7.0	5.2	5.3	2.6	2.0	1.2	1.8
8..........	3.2	6.5	3.0	5.6	3.4	7.6	4.8	5.9	2.2	1.9	1.1	1.8
9..........	3.0	9.6	2.8	5.2	3.3	5.4	3.3	3.0	2.0	1.9	1.1	1.8
10..........	2.8	12.5	5.5	4.5	3.1	4.3	2.6	2.6	2.0	1.8	1.1	1.8
11..........	8.8	10.5	7.8	4.3	3.0	4.0	2.4	2.5	2.0	1.7	1.0	2.6
12..........	23.5	7.6	8.0	4.2	2.9	3.8	2.3	3.4	2.0	1.6	1.0	2.6
13..........	27.0	6.5	6.7	4.3	2.8	3.8	2.0	3.0	1.8	1.8	1.0	2.1
14..........	23.8	5.6	4.8	10.4	2.8	4.0	2.0	2.3	2.0	2.0	1.0	2.2
15..........	21.4	5.0	4.0	10.1	2.7	4.3	2.0	4.5	3.0	3.2	1.0	16.4
16..........	19.8	4.8	3.6	7.7	2.6	6.9	1.9	7.2	2.4	2.6	1.0	17.6
17..........	17.4	4.2	3.2	5.8	2.6	6.0	1.7	10.5	6.0	2.4	1.0	14.7
18..........	8.9	4.2	3.0	5.2	2.5	5.0	5.5	9.8	11.2	2.4	1.0	11.0
19..........	5.0	4.2	3.0	9.0	2.5	4.8	3.0	10.8	11.1	2.0	1.0	13.0
20..........	4.0	4.0	3.0	18.6	3.0	4.0	3.0	12.5	7.0	1.8	1.0	5.6
21..........	3.8	3.8	3.0	17.2	10.0	3.8	2.4	10.8	3.9	1.8	1.6	3.0
22..........	3.8	3.7	3.0	15.5	23.6	3.6	2.4	14.5	3.7	1.6	1.2	3.0
23..........	3.8	3.6	3.0	14.6	26.4	3.6	2.4	20.8	3.3	1.6	1.4	2.0
24..........	3.8	3.6	3.6	12.7	21.8	3.6	2.0	23.2	2.8	1.6	1.4	3.6
25..........	6.7	3.5	3.6	6.8	18.9	2.7	2.0	18.3	2.6	1.6	1.3	4.0
26..........	6.6	3.2	22.0	5.6	16.5	2.7	1.9	13.1	2.5	1.4	1.3	3.7
27..........	5.4	3.2	27.0	4.8	11.1	3.2	1.7	6.6	2.3	1.3	1.3	5.7
28..........	5.2	3.0	24.5	4.4	5.5	3.0	2.8	8.8	2.0	1.3	1.3	6.0
29..........	5.0	......	21.3	4.2	4.9	3.6	1.9	7.5	2.0	1.3	1.3	21.5
30..........	4.6	......	19.2	4.1	4.7	3.6	1.9	6.2	2.5	1.3	1.3	29.8
31..........	6.8	......	16.1	......	5.4	...	1.6	5.6	......	1.2	......	32.6

Rating table for Coosa River at Rome, Ga., for 1900 and 1901.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second ft.*	*Feet.*	*Second ft.*	*Feet.*	*Second ft.*	*Feet*	*Second ft.*
0.8	1,930	1.6	2,850	2.4	4,000	3.2	5,230
0.9	2,020	1.7	2,985	2.5	4,150	3.3	5,405
1.0	2,110	1.8	3,120	2.6	4,300	3.4	5,580
1.1	2,230	1.9	3,260	2.7	4,450	3.5	5,755
1.2	2,350	2.0	3,400	2.8	4,600	*3.6	5,930
1.3	2,475	2.1	3,550	2.9	4,750		
1.4	2,600	2.2	3,700	3.0	4,900		
1.5	2,725	2.3	3,850	3.1	5,065		

***Above 3.6 ft. gage height, the rating for 1900-1901 is the same as for 1899.**

Estimated monthly discharge of Coosa River at Rome, Ga.

[Drainage area, 4,006 square miles.]

Month.	Discharge in second-feet.			Total in acre-ft.	Run-off.	
	Maxi-mum.	Mini-mum.	Mean.		Depth in inches.	Second-ft. per sq. mile.
1897.						
January	17,025	1,800	4,820	296,372	1.38	1.20
February	20,925	4,220	10,100	560,926	2.62	2.52
March	44,910	4,700	22,537	1,385,755	6.49	5.63
April	35,150	4,860	12,304	732,137	3.43	3.07
May	8,250	2,930	4,421	271,838	1.27	1.10
June	4,540	1,900	2,884	171,610	0.80	0.72
July	23,460	1,800	5,184	318,754	1.50	1.30
August	4,860	1,360	2,256	138,717	0.64	0.56
September	1,900	900	1,106	65,811	0.31	0.28
October	2,570	1,010	1,518	93,339	0.44	0.38
November	2,000	1,440	1,626	96,754	0.46	0.41
December	9.810	1,900	4,086	251,240	1.18	1.02
1898.						
January	26,970	2,220	7,272	447,138	2.10	1.82
February	5,520	2,110	2,705	150,228	0.71	0.68
March	20,730	2,110	4,384	269,563	1.27	1.10
April	32,040	4,540	9,430	561,123	2.63	2.36
May	4,220	2,330	2,778	170,814	0.79	0.69
June	5,520	2,110	2,866	170,538	0.80	0.72
July	6,690	1,900	3,670	225,661	10.59	9.17
August	17,805	2,930	6,079	373,786	1.75	1.52
September	45,885	3,060	12,114	720,832	2.26	3.03
October	44,910	3,060	11,830	727,403	3.41	2.96
November	12,150	3,060	5,213	310,194	1.45	1.30
December	8,250	3,610	4,996	307,194	1.44	1.25
1899.						
January	10.519	4,060	6,092	374,582	1.75	1.52
February	54,538	8,710	22,536	1,251,586	5.85	5.62
March	57,352	7,705	26,314	1,617,985	7.57	6.57
April	28,810	6,700	13,333	793,369	3.72	3.33
May	6,700	3,100	4,783	294,095	1.37	1.19
June	6,700	2,740	3,489	207,610	0.97	0.87
July	24,388	1,950	5,499	338,120	1.58	1.37
August	3,900	1,790	2,595	159,560	0.75	0.65
September	5,500	1,550	2,219	132,040	0.61	0.55
October	2,030	1,470	1,684	103,545	0.48	0.42
November	4,700	1,470	2,009	119,544	0.56	0.50
December	13.735	1,870	4,314	265.258	1.25	1.08

Estimated monthly discharge of Coosa River at Rome, Georgia.

[Drainage area, 4,006 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean		Depth in inches.	Second-ft. per sq. mile.
1900.						
January	21,373	2,725	6,854	421,436	1.97	1.71
February	53,332	2,850	14,736	818,396	3.83	3.68
March	33,835	6,300	14,714	904,728	4.33	3.67
April	25,996	5,755	12,050	717,025	3.36	3.01
May	11,122	3,850	5,129	315,370	1.48	1.28
June	35,242	4,000	14,154	842,222	3.94	3.53
July	19,765	4,000	7,589	466,629	2.18	1.89
August	5,580	2,725	3,488	214,469	1.00	0.87
September	20,971	1,930	3,960	235,636	1.10	0.99
October	10,519	2,010	3,408	209,550	0.98	0.85
November	21,775	2,600	5,438	323,583	1.52	1.36
December	14,740	3,400	7,096	436,316	2.04	1.77
The year	53,332	1,930	8,218	5,905,360	27.73	2.05

Estimated monthly discharge of Coosa River at Rome, Ga.

[Drainage area, 4,006 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Depth in inches.	Second-feet per square mile.
1901.					
January	52,930	4,600	15,450	4.45	3.86
February	35,845	4,900	12,186	3.17	3.04
March	52,930	4,600	13,406	3.85	3.34
April	36,046	6,901	15,578	4.33	3.88
May	51,724	4,150	12,533	3.60	3.12
June	19,966	4,450	8,316	2.32	2.08
July	9,715	2,850	4,441	1.27	1.10
August	45,292	2,850	13,780	3.97	3.44
September	21,172	3,120	6,389	1.77	1.59
October	5,230	2,350	3,414	.98	.85
November	2,850	2,110	2,316	.65	.58
December	64,186	2,475	13,428	3.86	3.35
The year	64,186	2,110	10,103	34.22	2.52

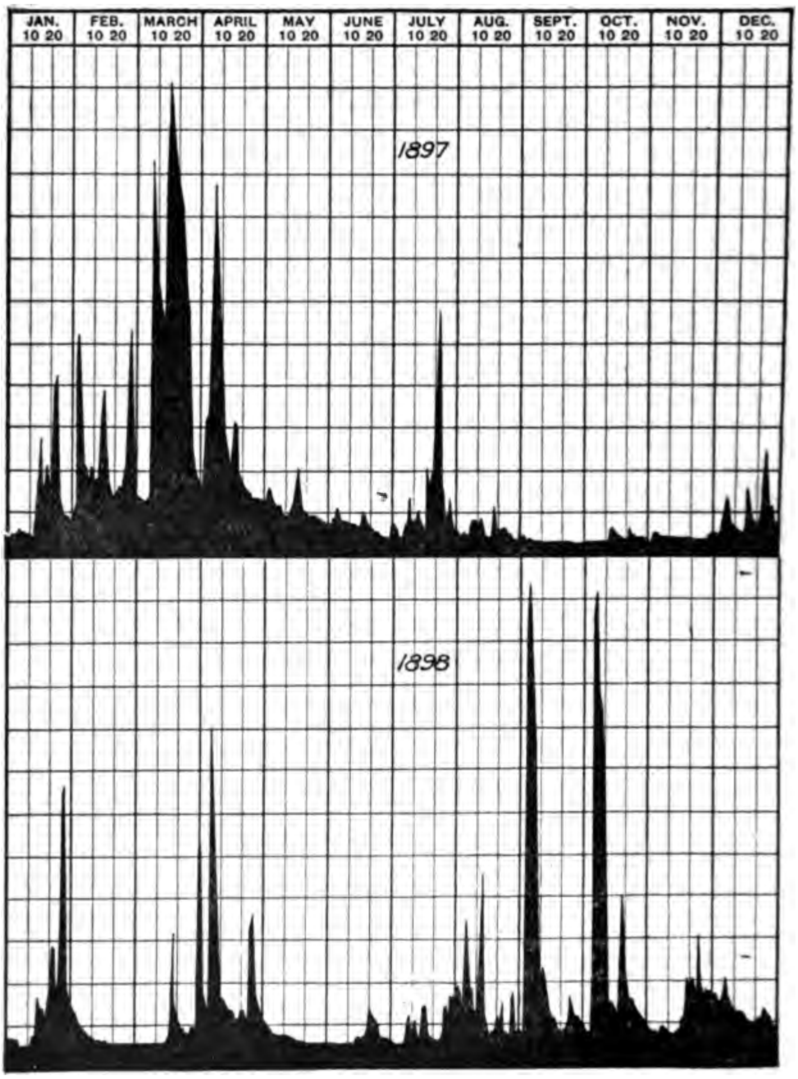

Fig. 12—Discharge of Coosa River at Rome, Ga., 1897 and 1898.

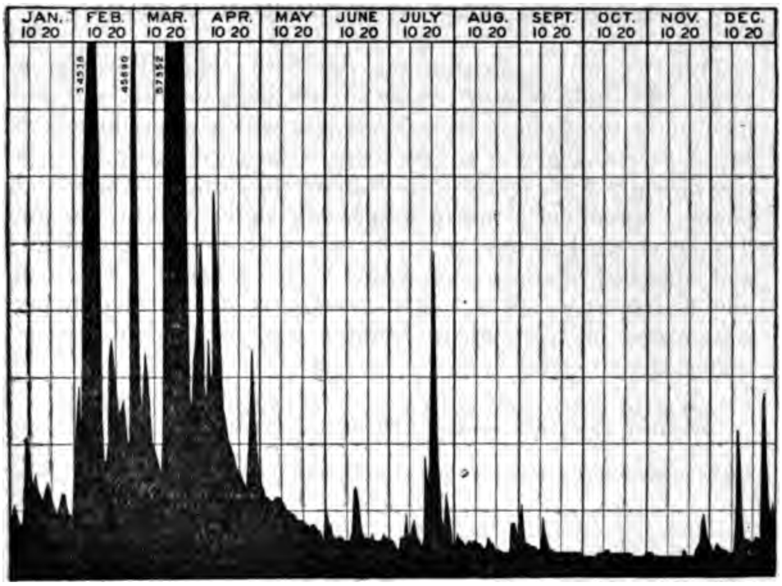

Fig. 13—Discharge of Coosa River at Rome, Ga., 1899.

Minimum monthly discharge of Coosa River at Rome, Ga., with corresponding net horse-power per foot of fall on a water wheel realizing 80 *per cent. of the theoretical power.*

	1899			1900			1901		
	Minimum cubic feet per second.	Minimum net H. P. per foot of fall.	No. of days duration of minimum.	Minimum cubic feet per second.	Minimum net H. P. per foot of fall.	No. of days duration of minimum.	Minimum cubic feet per second.	Minimum net H. P. per foot fall.	No. of days duration of minimum.
January ..	4,060	369	2	2,725	248	8	4,600	418	1
February .	8,710	792	2	2,850	259	1	4,900	445	1
March	7,705	700	1	6,300	573	1	4,600	418	1
April	6,700	609	1	5,755	523	1	6,901	627	1
May	3,100	282	2	3,850	350	1	4,150	377	2
June	2,740	249	4	4,000	364	1	4,450	405	2
July	1,950	177	1	4,000	364	3	2,850	259	1
August ...	1,790	163	3	2,725	248	3	2,850	259	2
September .	1,550	141	1	1,930	175	5	3,120	284	1
October ...	1,470	134	4	2,010	183	3	2,350	214	1
November .	1,470	134	7	2,600	236	2	2,110	192	10
December ..	1,870	170	4	3,400	309	2	2,475	225	3

Note.—To find the minimum net horse power available at a shoal on this stream, near this station, for any month, multiply the total fall of the shoal by the "Net H. P. per foot of fall" in this table for that month.

3. TALLADEGA CREEK AT NOTTINGHAM, ALABAMA.

This station is located on the Southern railroad bridge a fourth of a mile from the depot at Nottinghom, Ala, and one mile north of Alpine, Ala. The gage, which is graduated to feet and tenths and is 20 feet long, is fastened vertically to a tree on right bank about 50 feet above the bridge. The initial point of sounding is end of iron bridge right bank up stream. The bench mark is top rail on the upstream side of the bridge, and is 24.13 feet above gage datum. The station is a good one and is free from piers. The observer is R. M. McClatchy, station agent at Nottingham. During 1900 the following measurements were made by James R. Hall:

August 16—Gage height, 1.10 feet; discharge, 102 second-feet.
November 29—Gage height, 1.70 feet; discharge, 240 second-feet.

Daily gage height in feet of Talladega Creek at Nottingham, Ala., for 1900.

Day.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	Dec.
1	......	1.2	1.0	1.3	1.6	17	1.2	2.3	1.1	1.2	1.5
2	......	2.0	1.0	1.3	1.4	18	1.2	1.7	1.1	1.2	1.5
3	......	1.3	1.0	2.3	1.4	19	1.1	1.6	1.1	1.2	1.[illegible]
4	......	1.1	1.0	2.1	1.8	20	1.1	1.5	1.0	1.5	2.7
5	......	1.0	1.2	1.7	1.7	21	1.1	1.3	1.2	2.2	3.0
6	......	1.0	1.3	1.5	1.6	22	1.1	1.2	1.4	1.9	2.6
7	......	1.0	1.3	1.4	1.5	23	1.1	1.2	1.6	1.8	4.0
8	......	.9	1.4	1.4	1.5	24	1.0	1.2	2.9	1.6	2.5
9	......	11.0	1.3	1.3	1.4	25	.9	1.2	3.5	3.9	2.1
10	......	8.0	1.3	1.3	1.3	26	1.0	1.2	3.0	3.8	2.0
11	......	10.3	1.3	1.3	1.3	27	1.1	1.2	2.6	3.4	1.8
12	......	8.0	1.5	1.3	1.3	28	1.2	1.2	1.4	2.0	1.7
13	......	8.3	1.4	1.2	1.6	29	1.0	1.1	1.3	1.8	1.6
14	......	9.3	1.3	1.2	1.8	30	1.0	1.1	1.3	1.7	1.9
15	......	9.3	1.2	1.2	1.7	31	1.6	......	1.3	......	5.1
16	1.1	3.9	1.2	1.2	1.6						

The following discharge measurements were made during 1901 by Max Hall and others:

April 5—Gage height, 3.0 feet; discharge, 526 second-feet.
October 22—Gage height, 1.0 feet; discharge, 90 second-feet.

Daily gage height in feet of Talladega Creek at Nottingham, Ala., for 1901.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec
1..........	3.2	2.3	2.0	3.4	2.2	2.0	1.5	1.1	1.2	1.1	1.0	1.0
2..........	2.8	2.1	2.0	5.9	2.2	2.0	1.4	1.0	1.2	2.8	1.0	1.4
3..........	3.2	3.8	2.0	4.5	2.1	2.0	1.3	1.0	1.2	2.5	1.0	1.3
4..........	2.7	8.0	2.0	3.4	2.0	1.8	1.3	1.0	1.1	1.5	1.0	1.2
5..........	2.4	3.9	1.8	3.0	2.0	1.7	1.3	1.0	1.1	1.3	1.0	1.2
6..........	2.2	3.2	1.8	2.9	1.9	1.7	1.4	1.0	1.1	1.2	1.0	1.3
7..........	2.1	2.8	1.8	2.6	1.9	3.0	1.4	1.0	1.1	1.1	1.0	1.1
8..........	2.1	2.8	1.8	2.5	1.9	1.9	1.3	1.0	1.1	1.1	1.0	1.0
9..........	2.0	3.3	1.8	2.3	1.9	1.7	1.3	1.0	1.0	1.1	1.0	1.0
10..........	1.9	2.8	2.0	2.2	1.9	1.6	1.2	1.0	1.0	1.0	1.0	1.1
11..........	5.8	2.6	1.9	2.1	1.9	1.5	1.2	1.0	1.0	1.0	1.0	1.1
12..........	8.8	2.7	1.8	2.1	1.9	1.5	1.2	1.1	1.0	1.0	1.0	1.0
13..........	4.7	2.5	1.8	2.7	2.0	1.6	1.2	1.0	1.0	1.1	1.0	1.0
14..........	3.4	2.3	1.8	3.7	1.9	1.8	1.2	1.0	1.0	1.0	1.0	2.4
15..........	2.9	2.2	1.8	2.7	1.9	1.7	1.2	1.0	1.0	1.0	1.0	3.5
16..........	2.6	2.2	1.7	2.5	1.9	1.6	1.2	2.3	1.0	1.0	1.0	1.7
17..........	2.7	2.2	1.7	2.3	1.8	1.5	1.2	2.2	3.4	1.0	1.0	1.5
18	2.4	2.1	1.7	2.4	1.7	1.4	2.0	1.9	2.8	1.0	1.0	1.3
19..........	2.2	2.1	1.7	11.2	1.9	1.4	1.5	1.7	1.6	1.0	1.0	1.2
20..........	2.2	2.0	1.8	6.3	2.5	1.4	1.3	1.5	1.5	1.0	1.0	1.1
21..........	2.1	2.0	2.1	4.1	3.9	1.4	1.3	1.4	1.4	1.0	1.0	1.1
22..........	2.2	2.0	2.0	3.4	2.5	1.3	1.2	1.3	1.3	1.0	1.1	1.1
23..........	2.2	2.0	1.8	3.1	2.0	1.3	1.2	1.2	1.3	1.0	1.2	1.1
24..........	2.2	2.1	2.6	2.8	1.8	1.3	1.2	1.2	1.2	1.0	1.3	1.1
25..........	2.2	2.1	2.8	2.7	1.7	1.3	1.2	1.5	1.2	1.0	1.2	1.3
26..........	2.3	2.1	8.9	2.6	1.7	1.3	1.2	1.3	1.1	1.0	1.1	1.2
27..........	2.2	2.0	4.6	2.5	1.7	1.3	1.2	1.4	1.1	1.0	1.1	1.1
28..........	2.2	.20	3.3	2.4	1.7	1.3	1.2	1.5	1.1	1.0	1.0	1.2
29..........	2.2	......	2.8	2.3	1.7	1.3	1.2	1.4	1.1	1.0	1.0	8.4
30..........	2.6	......	2.9	2.2	1.7	1.4	1.2	1.3	1.1	1.0	1.0	7.5
31..........	2.5	......	5.5	......	2.2	...	1.2	1.2	......	1.0	......	3.5

Rating table for Talladega Creek at Nottingham, Ala., for 1900 and 1901.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second ft.*	*Feet.*	*Second ft.*	*Feet.*	*Second ft.*	*Feet.*	*Second ft.*
1.0	90	2.1	328	3.2	570	4.3	812
1.1	109	2.2	350	3.3	592	4.4	834
1.2	130	2.3	372	3.4	614	4.5	856
1.3	152	2.4	394	3.5	636	4.6	878
1.4	174	2.5	416	3.6	658	4.7	900
1.5	196	2.6	438	3.7	680	4.8	922
1.6	218	2.7	460	3.8	702	4.9	944
1.7	240	2.8	482	3.9	724	5.0	966
1.8	262	2.9	504	4.0	746		
1.9	284	3.0	526	4.1	768		
2.0	306	3.1	548	4.2	790		

NOTE.—This table applied to the foregoing "Daily gage heights" gives the cubic feet per second flowing in the river on each date for which the gage height is given.

Estimated monthly discharge of Talladega Creek at Nottingham, Ala.

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1900.					
August 16-31	....	....	113	0.72	0.43
September	2,286	74	575	3.69	4.12
October	636	90	190	1.22	1.41
November	724	130	249	1.60	1.79
December	746	152	291	1.87	2.16
1901.					
January	1,802	284	485	3.11	3.59
February	1,626	306	449	2.88	3.00
March	1,824	240	405	2.60	3.00
April	2,330	328	591	3.79	4.23
May	724	240	306	1.96	2.26
June	526	152	218	1.40	1.56
July	196	130	149	.96	1.11
August	372	90	148	.95	1.10
September	614	90	148	.95	1.06
October	482	90	123	.79	.91
November	152	90	97	.62	.69
December	1,714	90	264	1.69	1.95
The year	2,330	90	282	1.81	24.46

Minimum monthly discharge of Talladega Creek at Nottingham, Ala., with corresponding net horse-power per foot of fall on a water-wheel realizing* 80 *per cent. of the theoretical power.

	1900			1901		
	Minimum cubic feet per second.	Minimum net H. P. per foot of fall.	No. of days duration of minimum.	Minimum cubic feet per second.	Minimum net H. P. per foot of fall.	No. of days duration of minimum.
January	......	......	....	284	26	1
February	......	......	....	306	28	6
March	......	......	....	240	22	4
April	......	......	....	328	30	2
May	......	......	....	240	22	7
June	......	......	....	152	14	8
July	......	......	....	130	12	18
August	66	6	1	90	8	13
September	74	6.7	1	90	8	8
October	90	8	5	90	8	21
November	130	12	7	90	8	24
December	152	14	3	90	8	5

NOTE.—To find the minimum net horse power available at a shoal on this stream, near this station, for any month, multiply the total fall of the shoal by the "Net H. P. per foot of fall" in this table for that month.

4. ALABAMA RIVER AT SELMA, ALABAMA.

This station was originally established by the United States Engineer Corps; readings are now taken by the United States Weather Bureau. The gage, which is attached to the iron highway bridge, the floor of which is about 60 feet above low water, is in two sections. The lower section, which reads from —0.3 feet to +2.30 feet, is secured to the pile on the lower side of the cofferdam on the draw pier; the upper section, which reads from 2.30 feet to 48 feet, is spiked to the highway bridge. The bench mark, which is an iron bolt driven into the face of a rock bluff 182.3 feet from the first bridge pier, on the road ascending to the city, is 26 feet above the zero of the gage and 87.30 feet above mean sea level. The top of the coping stone of the pivot pier at the highway bridge to which gage is attached is 56 feet above the zero of the gage, and 117.30 feet above mean sea level. Graduations extend from —3.0 feet to +48 feet. No measurements of discharge were made here during 1899.

Daily gage height, in feet, of Alabama River at Selma, Ala., for 1899.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec
1	6.2	10.8	35.8	23.8	13.9	4.5	2.5	11.1	3.7	—1.2	—0.2	4.8
2	6.2	17.0	36.8	24.3	11.5	4.0	2.5	9.9	4.3	—1.3	— .3	3.7
3	6.5	20.2	38.8	24.9	9.9	4.0	2.6	9.0	4.6	—1.3	— .5	3.0
4	6.2	24.0	37.7	24.1	9.8	4.0	2.6	6.7	4.8	—1.3	— .6	3.0
5	6.2	26.8	35.3	22.3	8.5	3.8	2.1	6.5	4.4	—1.1	— .7	2.8
6	5.8	27.2	32.6	20.9	8.1	3.9	1.6	5.8	4.4	—1.0	— .7	2.8
7	6.6	27.2	30.5	20.0	7.5	3.8	1.6	5.3	4.1	—1.6	— .8	1.7
8	8.3	29.8	27.5	19.8	7.4	3.7	1.5	4.7	3.9	— .5	— .8	1.7
9	9.7	32.2	23.4	23.3	7.3	3.3	1.4	4.5	3.6	— .4	— .8	1.3
10	11.6	33.9	19.7	25.6	7.3	3.1	1.3	3.7	.6	— .4	— .9	1.3
11	13.9	34.4	16.9	26.9	7.5	2.8	1.3	3.5	.4	— .5	— .9	1.4
12	14.8	33.9	15.0	26.6	7.2	2.3	1.2	3.0	.3	— .6	—1.0	4.0
13	21.2	32.0	13.9	25.1	6.8	2.6	1.5	2.9	.3	— .6	—1.1	10.4
14	21.9	30.0	16.2	22.6	6.5	2.4	1.2	2.7	.2	— .2	—1.2	16.6
15	19.8	28.0	16.8	19.5	6.3	2.4	1.1	2.6	.2	— .2	—1.2	17.8
16	18.0	26.5	19.4	16.3	6.2	2.3	1.0	2.6	.1	— .2	—1.3	16.3
17	17.5	26.8	21.4	14.0	6.1	2.8	1.0	2.6	.6	— .3	—1.3	13.4
18	17.2	24.0	27.7	13.0	5.6	3.4	.7	3.6	1.3	— .5	—1.3	9.9
19	17.0	22.3	31.6	12.0	5.4	3.9	.6	4.1	1.0	— .7	—1.2	8.4
20	15.8	19.9	33.5	11.2	5.0	3.9	.6	4.3	.9	— .6	—1.0	3.8
21	14.2	19.9	34.7	10.5	4.8	3.1	1.0	3.6	.6	— .7	—1.0	3.8
22	12.6	19.5	34.8	10.4	4.5	2.8	1.6	3.5	— .6	— .8	— .6	3.4
23	10.2	18.8	34.2	10.2	4.4	1.6	5.5	3.4	— .7	— .2	— .6	3.4
24	10.3	17.8	33.4	10.1	4.8	1.4	10.7	3.1	— .8	.0	— .3	3.8
25	9.4	17.3	31.1	12.4	5.0	1.4	14.8	3.6	—1.0	.0	.1	7.6
26	9.0	16.4	32.6	13.5	6.0	1.6	17.0	4.2	—1.0	— .5	.2	12.2
27	8.9	20.3	31.8	16.3	6.1	1.7	17.0	3.9	—1.0	— .5	.9	13.5
28	8.6	31.2	30.5	17.9	5.2	2.0	14.9	3.6	—1.0	— .6	3.2	13.7
29	8.6	......	29.3	17.7	4.5	2.2	12.1	4.3	—1.1	— .6	1.6	12.8
30	9.0	......	27.8	16.1	4.3	2.4	12.8	4.6	—1.1	— .6	4.8	11.4
31	9.6	......	26.3	......	4.2	...	11.9	3.8	......	— .4	......	8.3

During 1900 the following measurements were made:

April 14—Gage height, 23.60 feet; discharge 66,607 second-feet.
May 26—Gage height, 6.10 feet; discharge, 17,049 second-feet.
August 24—Gage height, 3.10 feet; discharge, 9,879 second-feet.

Daily gage height, in feet, of Alabama River at Selma, Ala., for 1900.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec
1..........	7.2	4.8	17.2	19.8	15.4	4.8	34.8	14.0	3.9	0.8	2.0	16.0
2..........	6.6	3.6	19.7	16.8	13.9	4.6	33.0	13.0	3.9	.7	2.0	14.0
3..........	4.3	3.5	22.2	14.0	13.0	4.4	29.8	11.0	3.8	.6	4.0	11.0
4..........	3.3	3.9	22.0	12.0	12.0	4.2	26.5	9.0	4.5	.6	9.0	9.0
5..........	3.0	4.7	20.6	10.9	11.8	5.6	23.5	7.0	5.4	.5	14.0	8.0
6..........	3.0	6.2	17.8	8.0	10.2	5.1	20.2	6.0	5.0	1.0	13.5	7.5
7..........	3.0	8.2	15.0	7.8	9.6	4.6	17.0	5.5	4.5	1.8	9.4	7.0
8..........	3.0	8.4	13.9	8.9	8.8	4.2	14.0	5.0	4.1	2.5	6.3	7.0
9..........	2.7	8.5	14.9	9.6	8.0	6.8	11.5	4.8	3.3	4.0	4.0	9.0
10..........	2.7	10.7	18.8	9.5	7.8	11.6	10.0	4.5	1.8	4.2	2.0	9.4
11..........	3.3	16.0	20.9	9.8	7.5	13.5	9.8	3.2	1.0	2.0	2.0	6.0
12..........	7.7	22.2	22.2	12.0	7.3	14.0	10.2	3.0	.7	2.0	1.9	5.0
13..........	12.4	29.9	22.0	17.7	7.0	13.9	10.0	2.8	.6	2.5	1.6	2.0
14..........	13.5	38.6	19.9	23.4	6.6	12.8	9.9	2.5	1.0	4.3	1.6	3.2
15..........	14.7	44.0	19.0	25.5	6.4	11.0	9.9	2.5	1.6	6.7	1.0	9.0
16..........	14.0	47.0	16.9	25.0	6.0	9.0	10.0	2.4	11.0	6.0	1.0	11.0
17..........	13.2	48.0	15.3	22.5	5.7	8.9	9.9	2.8	18.0	5.2	1.0	11.0
18..........	12.0	47.9	13.9	23.5	5.5	8.8	9.0	2.7	19.0	2.5	1.0	10.0
19..........	11.1	47.0	14.3	29.0	5.2	8.6	7.0	2.7	19.4	1.0	1.0	8.0
20..........	11.1	44.1	14.6	34.8	5.1	10.0	7.0	2.5	16.0	1.0	1.9	5.1
21..........	13.4	41.6	18.8	39.0	5.0	10.9	6.5	2.3	12.5	.9	1.0	9.0
22..........	16.9	36.9	23.0	39.8	5.0	12.0	6.5	2.6	10.0	1.0	1.6	14.5
23..........	18.5	33.2	25.5	41.0	4.8	12.9	6.3	3.6	6.0	1.5	6.0	17.0
24..........	18.3	22.6	29.0	40.0	5.5	14.0	6.0	3.8	3.0	6.0	9.0	17.2
25..........	17.0	22.6	30.2	38.5	6.1	17.6	5.8	4.0	1.9	11.5	9.8	17.6
26..........	14.7	21.1	32.7	35.8	6.2	24.5	5.0	3.5	1.6	12.0	9.9	18.0
27..........	13.0	19.0	33.3	32.7	6.6	29.0	4.5	3.5	1.0	11.5	13.0	17.0
28..........	11.2	16.9	32.5	28.5	6.8	32.0	4.4	3.4	1.0	12.3	16.0	14.5
29..........	8.4	......	30.5	23.0	6.0	33.5	7.5	3.5	.9	13.0	16.8	12.9
30..........	6.5	......	27.7	18.0	5.5	35.0	8.0	4.0	.8	11.0	17.0	11.2
31..........	4.8	......	24.4	......	5.0	....	11.8	4.2	......	5.0	......	11.0

List of Discharge Measurements made on Alabama River at Selma, Alabama, in 1901.

Date, 1901.	Hydrographer.	Gage height, ft	Dischg. sec.-ft.
March 14.	**Max Hall**	**14.20**	**35,518**
April 25..	**J. R. Hall**	**34.00**	**90,332**
August 9..	**K. T. Thomas**	**4.35**	**12,519**
October 30	**Max Hall**	**1.10**	**7,710**

Daily gage height, in feet, of Alabama River at Selma, Ala., for 1901.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.
1..........	16.0	13.0	11.3	35.6	12.0	19.0	1.6	2.8	17.0	4.3	1.4	1.8
2..........	21.0	13.0	9.8	36.5	10.4	17.0	2.0	2.6	13.8	4.3	1.4	1.8
3..........	24.0	13.6	9.5	37.4	10.0	16.5	2.4	2.6	10.6	5.0	1.4	1.9
4..........	24.6	17.0	9.3	38.5	9.6	18.5	6.6	2.8	8.8	7.4	1.5	2.2
5..........	24.0	24.9	9.6	38.4	8.2	19.0	6.0	3.0	8.0	7.9	1.5	2.3
6..........	23.0	30.1	9.6	37.2	7.0	19.8	5.6	2.8	7.4	6.4	1.4	2.3
7..........	18.0	33.0	9.4	35.5	7.0	18.5	5.6	6.6	6.0	5.8	1.6	2.4
8..........	15.0	35.1	8.0	33.0	6.8	17.4	5.5	4.6	5.2	5.0	1.6	2.1
9..........	13.3	35.6	7.7	28.0	6.4	16.1	5.5	4.2	4.4	4.3	1.5	2.0
10..........	10.0	35.7	7.9	22.6	6.0	14.8	5.5	3.4	4.4	3.4	1.5	2.2
11..........	8.1	33.0	9.0	17.4	5.0	12.0	5.2	4.0	3.6	2.9	1.5	2.4
12..........	16.5	31.4	10.2	14.0	5.0	11.0	5.2	5.3	3.4	2.8	1.5	2.4
13..........	28.0	31.2	12.0	12.0	4.8	9.5	5.1	6.2	3.2	2.6	1.4	2.4
14..........	34.0	27.0	14.1	11.8	4.5	8.0	4.4	4.4	3.7	2.5	1.4	2.6
15..........	38.0	26.0	15.4	12.0	4.0	7.6	3.7	3.8	4.3	2.2	1.4	5.0
16..........	39.5	20.6	15.0	15.0	3.8	7.0	3.7	6.0	4.0	2.5	1.3	10.0
17..........	40.0	16.9	14.8	16.5	3.4	6.1	3.5	7.4	5.0	2.5	1.3	18.0
18..........	39.0	14.6	12.0	17.3	3.2	6.0	4.3	11.0	5.0	2.4	1.3	21.6
19..........	37.5	13.1	11.1	22.0	3.0	5.0	6.3	12.0	5.5	2.0	1.4	22.0
20..........	35.0	12.6	10.5	28.6	3.0	4.1	7.3	16.0	9.5	2.3	1.6	21.5
21..........	32.4	12.0	11.0	35.0	3.5	3.4	6.0	17.6	11.4	2.5	1.8	18.7
22..........	29.0	11.8	11.9	38.0	4.7	3.0	5.5	18.8	11.5	2.5	1.8	15.0
23..........	24.0	11.7	12.2	39.0	9.4	3.0	5.4	20.0	11.2	2.2	1.8	14.2
24..........	22.0	11.6	13.0	38.0	17.0	2.6	5.4	20.9	10.0	2.0	1.8	12.0
25..........	14.0	11.2	14.7	35.8	19.0	2.2	4.4	22.8	7.5	2.0	1.9	11.0
26..........	12.8	11.5	17.0	31.9	20.0	2.0	4.0	24.6	6.0	2.0	1.9	7.1
27..........	12.8	11.4	22.5	28.0	20.9	1.5	4.0	24.8	4.4	1.8	2.0	6.2
28..........	12.7	11.3	27.6	24.2	22.0	1.3	3.6	22.9	4.0	1.6	2.0	6.0
29..........	12.7	......	31.0	19.5	21.8	1.2	2.9	21.0	4.0	1.5	2.0	11.0
30..........	13.0	......	33.0	15.0	20.7	1.2	2.9	20.6	4.2	1.3	1.8	23.0
31..........	13.0	......	34.5	......	19.5	...	2.8	19.5	......	1.3	......	35.0

Rating table for Alabama River at Selma, Ala., for 1900 and 1901.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second ft.*	*Feet.*	*Second ft.*	*Feet.*	*Second ft.*	*Feet.*	*Second ft*
0.0	6,700	7.6	21,116	15.2	41,332	22.8	61,548
0.1	6,770	7.7	21,382	15.3	41,598	22.9	61,814
0.2	6,845	7.8	21,648	15.4	41,864	23.0	62,080
0.3	6,925	7.9	21,914	15.5	42,130	23.1	62,346
0.4	7,010	8.0	22,180	15.6	42,396	23.2	62,612
0.5	7,100	8.1	22,446	15.7	42,662	23.3	62,878
0.6	7,184	8.2	22,712	15.8	42,928	23.4	63,144
0.7	7,282	8.3	22,978	15.9	43,194	23.5	63,410
0.8	7,384	8.4	23,244	16.0	43,460	23.6	63,676
0.9	7,488	8.5	23,510	16.1	43,726	23.7	63,942
1.0	7,596	8.6	23,776	16.2	43,992	23.8	64,208
1.1	7,706	8.7	24,042	16.3	44,258	23.9	64,474
1.2	7,818	8.8	24,308	16.4	44,524	24.0	64,740
1.3	7,931	8.9	24,574	16.5	44,790	24.1	65,006
1.4	8,045	9.0	24,840	16.6	44,056	24.2	65,272
1.5	8,160	9.0	25,106	16.7	45,322	24.3	65,538
1.6	8,270	9.2	25,372	16.8	45,588	24.4	65,804
1.7	8,393	9.3	25,638	16.9	45,854	24.5	66,070
1.8	8,511	9.4	25,904	17.0	46,120	24.6	66,336
1.9	8,630	9.5	26,170	17.1	46,386	24.7	66,602
2.0	8,750	9.6	26,436	17.2	46,652	24.8	66,868
2.1	8,872	9.7	26,702	17.3	46,918	24.9	67,134
2.2	8,996	9.8	26,968	17.4	47,184	25.0	67,400
2.3	9,124	9.9	27,234	17.5	47,450	15.1	67,666
2.4	9,256	10.0	27,500	17.6	47,716	25.2	67,932
2.5	9,392	10.1	27,760	17.7	47,982	25.3	68,198
2.6	9,532	10.2	28,032	17.8	48,248	25.4	68,464
2.7	9,676	10.3	28,290	17.9	48,514	25.5	68,730
2.8	9,822	10.4	28,564	18.0	48,780	25.6	68,996
2.9	9,970	10.5	28,830	18.1	49,046	25.7	69,262
3.0	10,120	10.6	29,096	18.2	49,312	25.8	69,528
3.1	10,272	10.7	29,362	18.3	49,578	25.9	69,794
3.2	10,428	10.8	29,628	18.4	49,844	26.0	70,060
3.3	10,588	10.9	29,894	18.5	50,110	26.1	70,326
3.4	10,752	11.0	30,160	18.6	50,376	26.2	70,592
3.5	10,920	11.1	30,426	18.7	50,642	26.3	70,858
3.6	11,092	11.2	30,692	18.8	50,908	26.4	71,124
3.7	11,268	11.3	30,958	18.9	51,174	26.5	71,390
3.8	11,448	11.4	31,224	19.0	51,440	26.6	71,656
3.9	11,632	11.5	31,490	19.1	51,706	26.7	71,922
4.0	11,820	11.6	31,756	19.2	51,972	26.8	72,188
4.1	12,015	11.7	32,022	19.3	52,238	26.9	72,454
4.2	12,220	11.8	32,228	19.4	52,504	27.0	72,720
4.3	12,435	11.9	32,556	19.5	52,770	27.1	72,986
4.4	12,660	12.0	32,820	19.6	53,036	27.2	73,252
4.5	12,900	12.1	33,086	19.7	53,302	27.3	73,518

Rating table for Alabama River at Selma, Ala., for 1900 and 1901. Continued.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second ft.*	*Feet.*	*Second ft.*	*Feet.*	*Second ft.*	*Feet*	*Second ft.*
4.6	13,150	12.2	33,352	19.8	53,568	27.4	73,784
4.7	13,405	12.3	33,618	19.9	53,884	27.5	74,050
4.8	13,668	12.4	33,884	20.0	54,100	27.6	74,316
4.9	13,934	12.5	34,150	20.1	54,366	27.7	74,582
5.0	14,200	12.6	34,416	20.2	54,632	27.8	74,848
5.1	14,466	127.	34,682	20.3	54,898	27.9	75,114
5.2	14,732	12.8	34,948	20.4	55,164	28.0	75,380
5.3	14,998	12.9	35,214	20.5	55,430	28.1	75,646
5.4	15,264	13.0	35,480	20.6	55,696	28.2	75,912
5.5	15,530	13.1	35,746	20.7	55,962	28.3	76,178
5.6	15,796	13.2	36,012	20.8	56,228	28.4	76,444
5.7	16,062	13.3	36,278	20.9	56,494	28.5	76,710
5.8	16,328	13.4	36,544	21.0	56,760	28.6	76,976
5.9	16,594	13.5	36,810	21.1	57,026	28.7	77,242
6.0	16,860	13.6	37,076	21.2	57,292	28.8	77,508
6.1	17,126	13.7	37,342	21.3	57,558	28.9	77,744
6.2	17,392	13.8	37,608	21.4	57,824	29.0	78,040
6.3	17,658	13.9	37,874	21.5	58,090	29.1	78,306
6.4	17,924	14.0	38,140	21.6	58,356	29.2	78,572
6.5	18,190	14.1	38,406	21.7	58,622	29.3	78,838
6.6	18,456	14.2	38,672	21.8	58,888	29.4	79,104
6.7	18,722	14.3	38,838	21.9	59,154	29.5	79,370
6.8	18,988	14.4	39,104	22.0	59,420	29.6	79,636
6.9	19,254	14.5	39,370	22.1	59,686	29.7	79,902
7.0	19,520	14.6	39,676	22.2	59,952	29.8	80,168
7.1	19,786	14.7	40,002	22.3	60,218	29.9	80,434
7.2	20,052	14.8	40,268	22.4	60,484	30.0	80,700
7.3	20,318	14.9	40,534	22.5	60,750		
7.4	20,584	15.0	40,800	22.6	61,016		
7.5	20,850	15.1	41,066	22.7	61,282		

NOTE—This table applied to the foregoing "daily gage heights" gives cubic feet per second flowing in the river on each date for which the gage height is given.

Estimated monthly discharge of Alabama River at Selma, Ala.
[Drainage area, 13,500 square miles.]

Month.	Discharge in second-feet			Run-off.	
	Maximum.	Minimum.	Mean.	Depth in inches.	Second feet per square mile.
1900.					
January	50,110	9,676	26,495	1.96	2.26
February	128,540	10,920	63,763	4.72	4.91
March	89,478	37,874	58,272	4.32	4.98
April	109,960	21,648	60,909	4.51	5.03
May	41,864	13,668	21,090	1.56	1.80
June	94,000	12,220	35,288	2.61	2.91
July	93,468	12,660	33,964	2.52	2.90
August	38,140	9,124	14,156	1.05	1.21
September	52,504	7,189	17,366	1.29	1.44
October	35,480	7,097	14,492	1.07	1.23
November	46,120	7,596	18,506	1.37	1.53
December	48,780	8,750	28,989	2.15	2.48
The year	128,540	7,097	33,772	2.34	32.68
1901.					
January	107,300	22,446	61,213	4.53	5.22
February	95,862	30,692	55,037	4.08	4.25
March	92,670	21,382	39,017	2.89	3.33
April	104,640	32,288	73,048	5.41	6.04
May	59,420	10,120	26,966	2.00	2.31
June	53,568	7,818	26,030	1.93	2.15
July	21,318	7,596	13,536	1.00	1.15
August	66,868	9,532	30,853	2.29	2.64
September	46,120	10,428	19,394	1.44	1.61
October	21,914	7,931	11,022	.82	.95
November	8,750	7,931	8,266	.61	.68
December	94,000	8,511	26,638	1.97	2.27
The year	107,300	7,596	32,585	2.47	32.60

Minimum monthly discharge of the Alabama River at Selma, Ala., with corresponding net horsepower per foot of fall on a water wheel realizing 80 per cent. of the theoretical power.

[Drainage area. 15,400 square miles.]

	1899.			1900.			1901		
	Minimum cubic feet per second.	Minimum net H. P. per foot of fall.	No. of days duration of minimum.	Minimum cubic feet per second.	Minimum net H. P. per foot of fall.	No. of days duration of minimum.	Minimum cubic feet per second.	Minimum net H. P. per foot fall.	No. of days duration of minimum.
January	16,328	1,484	1	9,676	880	2	22,446	2,041	1
February ...	29,628	2,693	1	10,920	993	1	30,692	2,790	1
March	37,874	3,443	1	37,874	3,443	2	21,382	1,944	1
April	27,760	2,524	1	21,648	1,968	1	32,288	2,935	1
May	12,220	1,111	1	13,668	1,243	1	10,120	920	2
June	8,045	731	2	12,220	1,111	2	7,818	711	2
July	7,184	653	2	12,660	1,151	1	7,596	691	1
August	9,532	867	3	9,124	829	1	9,532	867	2
September ..	5,800	527	2	7,189	653	1	10,428	948	1
October	5,400	491	1	7,100	645	1	7,931	721	2
November ..	5,700	518	3	7,596	691	7	7,931	721	3
December ..	7,931	721	2	8,750	795	1	8,511	774	2

NOTE.—To find the minimum net horse power available at a shoal on this stream, near this station, for any month, multiply the total fall of the shoal by the "Net H. P. per foot of fall" in this table for that month.

5. MISCELLANEOUS DISCHARGE MEASUREMENTS

Made by B. M. Hall, and Assistants, on Tributaries of Coosa River.

1898.

May 26—Choccolocco Creek, Eureka; discharge, 171 second-feet; low water.

1900.

March 15—Talladega Creek, Kymulga postoffice; discharge, 107 second-feet; medium.

March 16—Tallassahatchee Creek, in Talladega county, Childersburg; discharge, 102 second-feet.

March 17—Hatchet Creek, Goodwater; discharge, 84 second-feet.

April 5—Choccolocco Creek, L. & N. R. R. bridge, near Jenifer; discharge, 1,170 second-feet; high water.

Oct. 16—Big Wills Creek, Wesson's Mill, 2 miles north of Attalla; discharge, 107 second-feet; low water.

6. TRIBUTARIES OF THE COOSA RIVER FROM WETUMPKA UP.

From which side.	Name of Stream.	Point on stream.	Drainage area, sq. miles.	Estimated discharge cu. ft per sec. low water 1900-1901.	Net H.P. per ft. of fall on 80 per cent. turbine.
Left..	Sofkahatchee Creek	Mouth of Creek	40	12	1.1
Left..	Wewoka Creek	Mouth of Creek	85	28	2.5
Right	Chestnut Creek	Mouth of Creek	90	30	2.7
Left..	Hatchet Creek	Mouth of Creek	500	165	15.0
Left..	Hatchet Creek	Goodwater, Ala	105	40	3.6
Left..	Pinthlocco Creek	Mouth of Creek	60	24	2.2
Right	Weogufka Creek	Mouth of Creek	120	48	4.3
Right	Waxahatchee Creek	Mouth of Creek	196	75	6.8
Right	Yellow Leaf Creek	Mouth of Creek	192	75	6.8
Left..	Tallasseehatchee Creek	Mouth of Creek	172	70	6.3
Left..	Talladega Creek	Mouth of Creek	188	75	6.8
Left..	Talladega Creek	Nottingham, Ala	156	66	6.0
Right	Kelley's Creek	Mouth of Creek	218	88	8.0
Left..	Choccolocco Creek	Mouth of Creek	510	153	13.9
Left..	Choccolocco Creek	Jenifer, Ala	273	95	8.6
Left..	Blue Eye Creek	Mouth of Creek	26	7	0.6
Right	Broken Arrow Creek	Mouth of Creek	49	18	1.6
Right	Trout Creek	Mouth of Creek	23	10	0.9
Left..	Cane Creek	Mouth of Creek	94	35	3.2
Left..	Ohatchee Creek	Mouth of Creek	217	85	7.7
Left..	Ohatchee Creek	Above Tallasseehatchee Creek	86	35	3.2
Left..	Tallasseehatchee Creek	Mouth of Creek	125	50	4.5
Right	Shoal Creek	Mouth of Creek	31	12	1.1
Right	Beaver Creek	Mouth of Creek	33	12	1.1
Right	Big Canoe Creek	Mouth of Creek	248	90	8.2
Right	Big Canoe Creek	Above Little Canoe Creek	165	65	5.9
Right	Little Canoe Creek	Mouth of Creek	34	14	1.3
Right	Big Wills Creek	Mouth of Creek	354	160	14.4
Right	Big Wills Creek	Above Little Wills Creek	249	115	10.4
Right	Big Wills Creek	Above Wesson Mill.	200	107	9.7
Left..	Black Creek	Mouth of Creek	59	25	2.3
Right	Little Wills Creek	Mouth of Creek	30	14	1.3
Left..	Ball Play Creek	Mouth of Creek	33	15	1.4
Left..	Terrapin Creek	Mouth of Creek	282	130	11.8
Right	Chattooga River	Above Little River..	384	170	15.4
Right	Chattooga River	Ala.-Ga. State Line	246	121	11.0
Right	Little River	Mouth of River	280	130	11.8
Right	Coosa River	Ala.-Ga. State Line	4340	2000	181.8

NOTE—To find the net horsepower available at a shoal on one of these streams, near a point given, for low water 1900-1901, multiply the total fall of the shoal by the "net horsepower per foot fall" in this table for that point.

7. WATER POWERS ON TRIBUTARIES OF COOSA RIVER IN ALABAMA.

On the above named tributaries there are many important water powers, very few of which have been surveyed. The above list giving the drainage area, the discharge for low season, 1900-1901, and the corresponding net horse power per foot fall for each of the streams will be very useful in estimating the horse power available on any shoal, the fall of which may hereafter be surveyed, by the owners, or by parties contemplating development.

Talladega Creek, in the vicinity of Taylor's Mill, has a fall of 73 feet in one mile, where it emerges from the Crystalline rocks. Taking the flow at Nottingham, we say that during the low water of 1900 and 1901 this 73 feet of fall would have produced 438 net horse power without storage. This 73 feet is probably the most precipitous shoal on the large creek, but above it for four or five miles the creek has a number of rapids and shoals that will admit of good development.

The head waters of this stream in the neighborhood of the pyrites mines in Clay county have high falls on them.

Choccolocco Creek is a very large and constant stream, and has many rapids where good powers could be developed by dams. During a season such as low water of 1900 or 1901 a 10-foot dam near Jenifer would develop 86 net H. P. A 10-foot dam at any point near the mouth of the creek would develop 140 net H. P. during the given season.

Big Wills Creek, at the old Wesson mill, two miles north of Attalla, has a good site for a 25-foot dam. The flow at this point on October 16, 1901, was 107 second-feet, which with a fall of 25 feet, will give 242 net H. P. The fall on other tributaries named has not been ascertained.

8. COOSA RIVER SURVEY.

The Coosa River has its beginning at the junction of the Etowah and Oastanaula Rivers, at Rome, Ga., a short distance west of the Alabama line.

From Rome down to Greensport, Ala., a distance of about 180 miles by river, navigation has been carried on for many years. The total fall in this section is only about 55 feet, and is so well distributed that it has not been necessary to construct locks at any point, though improvements have been made by the U. S. Government in the way of deepening channels, blasting out reefs, and building wing dams, etc.

This part of the river will, therefore, not be considered as having any water power value.

Below Greensport, Ala., the river has a large amount of fall, and although it is proposed to make the whole distance navigable by the construction of locks, there are many fine water power propositions which can be developed in connection with the river improvements without interfering with navigation.

A complete survey has been made of this portion of the river by the U. S. engineers, and a system of locks planned.

The profile herein presented is reproduced from that survey, and shows in addition to the river profile the location of the proposed locks, and the lift of each.

It will be seen that the total distance between Greensport and Wetumpka, Ala., is 142 miles, and the number of locks proposed, 31, varying in lift from 5.83 feet to 15.0 feet. Of these only three have been completed; Nos. 1, 2, and 3. No. 4 is in process of construction.

The following table shows the lift or fall at each lock, the discharge of river in cubic feet per second, for the minimum low stage of water in 1897 and in 1900, and the equivalent net horse power for the fall shown.

The minimum low water is based on the exceptionally low stages occurring in 1896 and 1897, which represents the lowest stage of which there is any record; while the minimum for the year 1900 represents lowest water for average years.

In estimating the amount of horse power that will be available for use, it will be necessary to deduct the amount of water which will be necessary for lockage. This will depend upon the amount of traffic on the river, but will probably in no case amount to more than ten per cent. of the river discharge.

At most of these locks, and proposed locks, reservations have been made by the original owners of the river front of the privilege of utilizing for power the water not needed for lockage. By constructing a plant at the opposite end of the Government dam from the lock, the surplus water can be used for power without interfering with navigation. Such powers will be very valuable for running cotton mills, as the cotton furrows will run up to the front door of the factory, and water transportation will take the goods from the back door. Mobile, at the mouth of the river, is only a short distance from the proposed Isthmian canal.

9. TABLE OF DISCHARGE, AND NET H. P. AT THE 31 LOCKS AND PROPOSED LOCKS ON THE COOSA RIVER AT LOWEST WATER OF 1897 AND 1900.

[80 % of Theoretical H. P.]

Miles from Wetumpka, Ala.	Lock No.	Tide Water Elevation top of lock.	Lift or Fall in feet at lock.	Minimum Low Water, 1897.		Minimum Low Water, 1900.	
				Cubic ft. per second.	Net H. P.	Cubic ft. per second.	Net H. P.
141.5	1	521.30	5.33	1,320	640	2,700	1,308
138.5	2	515.97	5.57	1,320	668	2,700	1,367
137.0	3	510.40	12.00	1,320	1,440	2,700	2,945
116.2	4	492.30	10.00	1,350	1,227	2,760	2,510
105.8	5	482.30	12.00	1,350	1,472	2,760	3,012
92.0	6	455.32	10.00	1,440	1,310	2,940	2,673
88.3	7	445.32	10.00	1,450	1,317	2,960	2,690
81.3	8	435.32	12.00	1,490	1,625	3,040	3,317
56.2	9	420.00	8.00	1,580	1,149	3,220	2,342
53.5	10	412.00	12.00	1,585	1,728	3,230	3,523
46.7	11	399.64	10.00	1,585	1,440	3,230	2,936
44.9	12	389.64	10.00	1,600	1,454	3,260	2,964
43.0	13	379.64	12.00	1,600	1,745	3,260	3,557
41.9	14	367.64	12.00	1,600	1,745	3,260	3,557
40.2	15	355.64	10.00	1,605	1,460	3,270	2,973
37.5	16	345.64	14.00	1,605	2,044	3,270	4,162
36.1	17	331.64	15.00	1,605	2,190	3,270	4,460
34.8	18	316.64	13.00	1,610	1,903	3,280	3,877
33.8	19	303.64	12.00	1,610	1,757	3,280	3,578
31.5	20	291.64	10.00	1,610	1,464	3,280	2,982
25.5	21	281.33	10.00	1,700	1,545	3,460	3,145
21.4	22	270.80	12.00	1,700	1,854	3,460	3,774
18.5	23	258.80	14.00	1,710	2,175	3,480	4,430
16.3	24	244.80	10.00	1,710	1,554	3,480	3,164
12.9	25	234.80	10.00	1,710	1,554	3,480	3,164
11.7	26	224.80	12.00	1,720	1,877	3,500	3,818
8.8	27	212.80	14.00	1,720	2,190	3,500	4,455
7.4	28	198.80	12.00	17,20	1,877	3,500	3,818
4.6	29	186.37	8.00	1,740	1,266	3,540	2,574
2.0	30	178.37	10.00	1,740	1,582	3,540	3,218
0.0	31	168.37	14.00	1,740	2,215	3,540	4,505
Total net H. P.					49,467		100.798

Locks and proposed locks on Coosa River are located as follows:

Lock No. 1 is one mile south of Greensport, Ala., and five miles north of Singleton, which is a station on the East & West Railroad of Alabama. Lock No. 1 is three miles above lock No. 2.

Lock No. 2 is one and a half miles above lock No. 3, and is located at the head of Woods Island,, and two miles northeast of Singleton, Ala., which is a station on the East & West Railroad. This lock is situated at the head of Ten Island Shoal Canal.

Lock No. 3 is one and a half miles below lock No. 2, near the foot of Woods Island, and on Ten Island Shoal Canal. It is one mile east of Singleton, Ala., and 20.8 miles above lock No. 4.

Lock No. 4 is three and a half miles above the U. S. G. S. Hydrographic Station, Riverside, Ala., and three miles northwest of Lincoln, Ala. Lincoln and Riverside are on the Georgia Pacific division of the Southern Railway. Lock No. 4 has a lift of 12 feet, and is three-quarters of a mile below Denson's Island, and ten miles above proposed lock No. 5.

Proposed lock No. 5 is to be at the head of Ogletree Island, one mile above the mouth of Choccolocco Creek, and five miles northeast of Hamilton, on the Talladega & Coosa Valley Railroad. Has a lift of ten feet.

Proposed lock No. 6 is to be located one-fourth of a mile above the mouth of Upper Clear Creek, one and a half miles above Grissom's Ferry, and nine miles north-east of Vincent, which is a station on the Columbus & Western division of the Central of Georgia Railroad.

Proposed lock No. 7 is to be located two miles above Kelly Creek, and five and a half miles north-east of Vincent, Ala.

Proposed lock No. 8 is to be located at Myer's Ferry, at the mouth of Lower Clear Creek, six miles east of Harpersville, and three miles north-east of Creswell, which is a station on the Columbus & Western division of the Central of Georgia Railroad.

Proposed lock No. 9 is to be located at the mouth of Kelly Branch, at Fort Williams Shoals. It is to be thirteen and a half miles east of Columbiana, Ala., and eight miles east of Shelby, Ala.

Lock No. 10 is to be located a half mile above Peckerwood Creek, at the foot of Peckerwood Shoals, and is eight miles east of Shelby, Ala., and two miles west of Talladega Springs, Ala.

Lock No. 11 is to be located at the foot of Weduska Shoals, immediately above the narrows, two miles above Waxahatchee Creek, and six miles south-east of Shelby, Ala., which is a station on the Shelby Iron Works Railroad, connecting with the E. T., V. & G. R. R. at Columbiana, Ala.

Lock No. 12 is to be located 1.8 miles below lock No. 11, immediately below the mouth of Waxahatchee Creek, and eight miles south-east of Shelby, Ala.

Lock No. 13 is to be located 1.9 miles below lock No. 12, at a place known as Devil's Race, three miles above the mouth of Lower Yellow Leaf Creek, and sixteen miles north-east of Clanton, Ala., on the L. & N. R. R.

Lock No. 14 is to be located one mile below lock No. 13, two miles above Yellow Leaf Creek, and fourteen miles north-east of Clanton, Ala.

Lock No. 15 is to be located 1.7 miles below lock No. 14, three-tenths of a mile above Lower Yellow Leaf Creek, and twelve miles north-east of Clanton, Ala., on the L. & N. R. R.

Lock No. 16 is to be located 2.7 miles below lock No. 15, at Butting Ram Shoals, which is eleven miles north-east of Clanton, Ala.

Lock No. 17 is to be located 1.4 miles below lock No. 16, and is ten and a half miles north-east of Clanton, Ala.

Lock No. 18 is to be located 1.3 miles below lock No. 17, and eleven miles east of Clanton, Ala.

Lock No. 19 is to be located one mile below lock No. 18, about eleven miles east of Clanton, Ala.

Lock No. 20, 31.5 miles above Wetumpka, one-fourth mile above Zimmerman's Ferry, 1.2 miles above the mouth of Hatchet Creek.

Lock No. 21, 25.5 miles above Wetumpka, 1.6 miles below mouth of Blue Creek, 7 miles east of Cooper, Ala., on L. & N. R. R.

Lock No. 22, 21.4 miles above Wetumpka, three-fourths of a mile below the mouth of Proctors Creek, and 1.1 miles above the mouth of Pinchoulee Creek, and 7 miles east of Verbena, Ala., on the L. & N. R. R.

Lock No. 23, 18.5 miles from Wetumpka, 1.5 miles below the mouth of Pinchoulee Creek.

Lock No. 24, 16. miles above Wetumpka, 0.4 miles below the mouth of Welcree Creek, and seven and a half miles east of Mountain Creek Station, on the L. & N. R. R.

Lock No. 25, 12.9 miles above Wetumpka, 0.1 miles above the mouth of Shoal Creek, and about 8 miles east of Wadsworth, Ala., on the L. & N. R. R.

Lock No. 26, 11.7 miles above Wetumpka, at Staircase Falls, just above the mouth of Wewoka Creek.

Lock No. 27, 8.8 miles above Wetumpka, 0.6 miles above the mouth of Sofkahatchee Creek, and about nine miles east of Deatsville, Ala., on the L. & N. R. R.

Lock No. 28, 7.4 miles above Wetumpka.

Lock No. 29, 4.6 miles above Wetumpka.

Lock No. 30, 2 miles above Wetumpka.

Lock No. 31, at Wetumpka, Ala.

CHAPTER IV.

1. CAHABA RIVER AT CENTERVILLE, ALABAMA.

Centerville Station, on Cahaba River, is at the Bibb county highway bridge, one-fourth of a mile west of the court house at Centerville, Ala. The bridge is a single span iron through bridge. The length of the span is about 175 feet. The floor of the bridge is 41½ feet above low water, and the stream is 130 feet wide at low water.

The initial point of sounding is at the end of the iron bridge, left bank, down stream. The gage is a wire gage, with rod fastened to the outside of down stream guard rail, and graded to feet and tenths. The gage pulley is at Station 100. Bench mark No. 1, down stream end of top of iron crossbeam under the bridge floor at Station 100, from initial point is 42.85 above gage datum.

Bench mark No. 2, top of bottom flange of same crossbeam, directly under B. M. No. 1, is 41.40 above datum of gage.

Banks are high, but overflow at time of high water.

The section is swift, and tolerably uniform, and the bottom appears to be rock.

The river observer is Mr. S. D. Hall, a merchant, who lives about a quarter of a mile from the gage.

The following discharge measurements have been made on Cahaba River at Centerville, Ala.:

1901.

April 25—Hydrographer, J. R. Hall; gage height, 5.50; discharge, 1,925 second-feet.

Aug. 7—Hydrographer, K. T. Thomas; gage height, 1.30; discharge, 399 second feet.

1902.

Jan. 25—Hydrographer, K. T. Thomas; gage height, 5.15; discharge, 1,707 second-feet.

Daily gage height of Cahaba River at Centerville, Ala, for 1901.

Day	Aug.	Sept.	Oct.	Nov.	Dec	Day	Aug.	Sept.	Oct.	Nov.	Dec
1	......	2.20	2.10	1.20	1.4	17	7.70	2.10	1.30	1.30	12.3
2	......	2.00	2.00	1.20	1.3	18	8.10	2.60	1.30	1.30	4.4
3	......	1.90	1.80	1.20	1.6	19	9.10	3.90	1.30	1.70	3.6
4	......	1.80	1.40	1.20	1.9	20	10.60	4.10	1.30	1.60	3.1
5	......	1.60	2.30	1.20	1.8	21	14.70	2.00	1.30	1.60	2.9
6	......	1.50	4.60	1.10	1.6	22	10.30	1.90	1.30	1.50	2.6
7	1.30	1.40	3.10	1.10	1.7	23	7.90	1.80	1.30	1.60	2.5
8	1.30	1.40	2.60	1.10	1.6	24	5.60	1.60	1.20	1.60	2.6
9	1.20	1.40	2.30	1.20	1.7	25	4.80	1.50	1.20	1.50	2.7
10	1.20	1.40	1.90	1.20	2.1	26	4.10	1.40	1.20	1.50	2.7
11	1.20	1.30	1.60	1.20	2.0	27	3.90	1.40	1.20	1.50	2.7
12	1.20	1.30	1.40	1.30	1.8	28	3.40	1.40	1.20	1.40	6.0
13	1.30	1.30	1.40	1.40	1.9	29	3.00	2.60	1.30	1.40	24.0
14	1.50	2.60	1.40	1.30	2.9	30	2.80	2.20	1.30	1.40	24.0
15	2.10	2.40	1.30	1.30	19.0	31	2.50	....	1.30	....	21.0
16	7.90	2.00	1.30	1.30	15.0						

Rating table for Cahaba River at Centerville, Alabama, for year 1901.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second ft.*	*Feet.*	*Second ft.*	*Feet.*	*Second ft.*	*Feet.*	*Second ft.*
1.1	326	4.9	1,694	8.7	3,062	12.5	4,430
1.2	362	5.0	1,730	8.8	3,098	12.6	4,466
1.3	398	5.1	1,766	8.9	3,134	12.7	4,502
1.4	434	5.2	1,802	9.0	3,170	12.8	4,538
1.5	470	5.3	1,838	9.1	3,206	12.9	4,574
1.6	506	5.4	1,874	9.2	3,242	13.0	4,610
1.7	542	5.5	1,910	9.3	3,278	13.1	4,646
1.8	578	5.6	1,946	9.4	3,314	13.2	4,682
1.9	614	5.7	1,982	9.5	3,350	13.3	4,718
2.0	650	5.8	2,018	9.6	3,386	13.4	4,754
2.1	686	5.9	2,054	9.7	3,422	13.5	4,790
2.2	722	6.0	2,090	9.8	3,458	13.6	4,826
2.3	758	6.1	2,126	9.9	3,494	13.7	4,862
2.4	794	6.2	2,162	10.0	3,530	13.8	4,898
2.5	830	6.3	2,198	10.1	3,566	13.9	4,934
2.6	866	6.4	2,234	10.2	3,602	14.0	4,970
2.7	902	6.5	2,270	10.3	3,638	14.1	5,006
2.8	938	6.6	2,306	10.4	3,674	14.2	5,042
2.9	974	6.7	2,342	10.5	3,710	14.3	5,078
3.0	1,010	6.8	2,378	10.6	3,746	14.4	5,114
3.1	1,046	6.9	2,414	10.7	3,782	14.5	5,150
3.2	1,082	7.0	2,450	10.8	3,818	14.6	5,186
3.3	1,118	7.1	2,486	10.9	3,856	14.7	5,222
3.4	1,154	7.2	2,522	11.0	3,890	14.8	5,258
3.5	1,190	7.3	2,558	11.1	3,926	14.9	5,294
3.6	1,226	7.4	2,594	11.2	3,962	15.0	5,336
3.7	1,262	7.5	2,630	11.3	3,998	15.1	5,366
3.8	1,298	7.6	2,666	11.4	4,034	15.2	5,402
3.9	1,334	7.7	2,702	11.5	4,070	15.3	5,438
4.0	1,370	7.8	2,738	11.6	4,106	15.4	5,474
4.1	1,406	7.9	2,774	11.7	4,142	15.5	5,510
4.2	1,442	8.0	2,810	11.8	4,178	15.6	5,546
4.3	1,478	8.1	2,846	11.9	4,214	15.7	5,582
4.4	1,514	8.2	2,882	12.0	4,250	15.8	5,618
4.5	1,550	8.3	2,918	12.1	4,286	15.9	5,654
4.6	1,586	8.4	2,954	12.2	4,322	16.0	5,690
4.7	1,622	8.5	2,996	12.3	4,358		

NOTE.—This table applied to the foregoing "Daily gage heights" gives the cubic feet per second flowing in the river on each date for which the gage height is given.

Minimum monthly discharge of Cahaba River at Centerville, Ala., with corresponding net horsepower per foot of fall on a water wheel realizing* 80 *per cent. of the theoretical power.

	1901.		
	Minimum cubic feet per second.	Minimum net H. P. per foot of fall	No. of days duration of minimum.
August	362	33	4
September	398	36	3
October	362	33	5
November	326	30	3
December	398	36	1

NOTE.—To find the minimum net horse power available at a shoal on this stream ,near this station, for any month, multiply the total fall of the shoal by the "net H. P. per foot of fall" in this table for that month.

2. SURVEY OF CAHABA RIVER, ALABAMA.

The Cahaba River rises near Birmingham, Alabama, and flowing in a southerly direction, enters the Alabama River at a point just below Selma, Alabama.

From the published notes of a survey made by the Corps of Engineers, U. S. A., a profile has been made beginning at the southwestern boundary of Shelby county, and running down the river a distance of 110 miles to its mouth, in which distance there is a fall of 227 feet.

A United States Geological Survey hydrographic station has been established at Centerville, Ala,. and measurements of discharge have also been made at Sydenton, near Birmingham, but the measurements and observations have not extended over a sufficient length of time to give accurate estimates of discharge at all seasons. The best that can be done at present is to form an estimate of the river discharge for ordinary low stage of water at Centerville, which is 344 second-feet, and add to or subtract from this amount for other points on the river. From measurements made on the same day at Centerville and at Harrell, near the mouth of the river, we estimate that the flow at Centerville is about one-third of that at the mouth of the river.

On the accompanying profile the stations are one mile apart, and are numbered from zero at the mouth of the river, up to 110 at the Shelby county line. In the following description of powers that can be developed these mile stations will be referred to as stations:

Power No. 1.—From the head of "Half Mile Rapids" at Station 108 there is a succession of shoals known as Half Mile, Long Island, Fish Trap, Ford, Reach, and Dry Creek Shoals, in which the aggregate fall is 30 feet in 2¼ miles. There is also a fall of about 4 feet from the Shelby County line down to the head of Half Mile Shoal, making a total fall of 34 feet in four miles. This can be developed either by building a dam 34 feet high at the mouth of Dry Creek and backing the water to the Shelby County line, or by building a low dam near the head of the shoals, and a canal from it to a point opposite the mouth of Dry Creek. Such a development will give about 500 net horse-power, with an 80% turbine at ordinary low season. This power would be near Blocton, Ala.

Power No. 2.—By building a 15-foot dam at the head of "Baily Reach Rapids," near Station 101, and near the mouth of Big Ugly Creek, to back the water to the mouth of Persimmon branch near Station 104, and constructing from this point a canal along the river bank about four miles long, to a point opposite Station 97, at the mouth of Little Cahaba River, a practical head of 54 feet can be developed. This allows 8 feet for storage and grade, as the total fall is 62 feet. A 54-foot fall would produce about 800 net H. P.

The same power can be developed by building a high dam, lower down the river, and having the canal shorter. Or, the power can be divided into two separate powers. This power site is between River Bend and Cadle, in Bibb County.

Power No. 3.—From the mouth of Little Cahaba down to Station 88½ at the top of Centerville Shoals, there is a fall of ten feet in 8½ miles, and from the top of Centerville Shoals down to the foot of Centerville Shoals at Centerville, there is a fall of 13.6 feet in about 1¾ miles. This power can be developed by a ten-foot dam at top of Centerville Shoals, and a canal from there to Centerville 1½ miles long. Allowing 2.6 feet for storage and canal grade, a head of 21 feet can be obtained which will give 650 net H. P.

It is probable that a much better method of development will be to erect a dam at Centerville 23.6 feet high to back the water to the mouth of Little Cahaba. This will produce 732 net H. P., with storage. The incidental storage of such a dam would add largely to the amount and efficiency of the power. A plant running only 12 hours per day, and storing the water at night, could utilize 1,440 net H. P.

This power site is at Centerville, Alabama, on the M. & O. Railroad.

Power No. 4.—A 16-foot dam can be built at Shoal No. 9, Station 69½, in Perry County, just below the Bibb County line. This dam would back the water for 12 miles to Shoal No. 2, 4½ miles below Centerville. A 16-foot head will produce 670 H. P. without storage, or 1,340 H. P. by storing the water at night, and running only twelve hours per day. This dam site is about 17 miles below Centerville by river.

Power No. 5.—A 15-foot dam at "Blocks Cut-off," near Station 55, will back the water ten miles to the mouth of Taylor's Creek, and will produce 750 continuous, or 1,500 twelve-hour horse power.

Power No. 6.—At Shoal No. 24, Station 50, there is a fall of 9 feet in less than half a mile. A 14-foot dam at foot of this shoal, or a 5-foot dam at its head, and a short canal will develop a head— of 14 feet and realize 720 continuous, or 1,400 twelve-hour H. P.

This site is just above Burras Island, 8 or 10 miles northeast of Marion, Ala.

Power No. 7.—From Burras Island to Fikes Ferry there is a fall of 22 feet in a distance of 7 miles, 20 feet of which could probably be utilized by a dam at Fikes Ferry, producing 1,100 continuous, or 2,200 twelve-hour H. P. Fikes Ferry is near Marion, Ala.

In making the above statement of powers that can be developed, it has been assumed that there are suitable banks for dam sites. The system proposed, or some other system approximating to it, would not interfere with navigation improvements, as locks could be constructed at the dams.

CHAPTER V.

BLACK WARRIOR RIVER AND TRIBUTARIES

1. TUSCALOOSA STATION ON BLACK WARRIOR RIVER.

This gage was placed in position by the United States Corps of Engineers in 1888. It is about three-fourths of a mile from the business center of Tuscaloosa, Alabama, and is reached by passing down Bridge street to the river, thence down the east bank 1,800 feet to the gage. It consists of an inclined timber, 2x6 inches, supported on posts and graduated by means of notches placed 1 foot vertically apart. The observer is W. S. Wyman, Jr., Tuscaloosa, Alabama. Mr. Wyman is observer for the Corps of Engineers, and has been kind enough to send weekly reports to this office. Observations are taken daily at 7 A. M. The area draining past this point is 4,900 square miles.

The bench marks are fixed, one on a willow 10 feet west of gage, 97.84 feet above Mobile datum, the other on a small hackberry 30 feet south of the upper end of the gage and 139.36 feet above Mobile datum. The current here is rather sluggish, being almost imperceptible at low stages. Both banks are of earth, and subject to overflow. Observations of gage heights have been obtained through the courtesy of Mr. R. C. McCalla, Jr., of the United States Engineers in charge of the Black Warrior River, from the time the gage was established until December 31, 1896. A measurement made by Mr. McCalla September 14, 1896, showed a gage height of —0.60 foot area, 1,022 square feet, mean velocity 0.16, discharge 164 second-feet.

The following list of measurements at the same place has been furnished by Mr. Horace Harding, C. E., United States assistant enginee, 2016 Quinlan avenue, Birmingham, Alabama. Velocities were obtained by means of rod floats reaching from the water surface to near the bottom. The highest flood occurred on April 8, 1892. The gage height was 62.5, the sectional area 33,600 square feet, and the estimated mean velocity 4.5 feet per second. This gave a discharge of 151,200 cubic feet per second. From this estimate and the following list of measurements a curve has been plotted and a rating table constructed, and this rating table applied to all gage heights observed. The estimates of discharge thus obtained are shown in diagrammatic form in Plate V. The highest discharges are merely approximations, but the discharges shown by the diagrams serve as a basis for comparison of the state of the river during the various years.

List of Discharge Measurements made on Black Warrior River at Tuscaloosa, Alabama.

No.	Date.	Gage height.	Discharge.	Remarks.
	1895.	*Feet.*	*Second-feet.*	
1	Dec. 17	1.10	617	Stationary.
2	Dec. 21	2.61	1,344	Do.
3	Dec. 24	3.60	1,733	Rising slowly.
	1896.			
4	Jan. 30	9.99	5,073	Falling 0.05 per hour.
5	Jan. 31	8.65	4,363	Do.
6	Feb. 26	8.25	4,360	Falling 0.01 per hour.
7	Feb. 28	7.27	3,657	Falling 0.02 per hour.
8	Feb. 29	6.92	3,522	Stationary.
9	Mar. 2	7.67	4,211	Do.
10	Mar. 3	7.28	3,632	Falling 0.03 per hour.
11	Mar. 6	6.94	4,558	Rising 0.15 per hour.
12	Mar. 24	24.85	13,550	Falling 0.12 per hour.
13	Apr. 10	9.71	5,331	Falling.
14	Apr. 11	8.89	4,755	Do.
15	Apr. 14	8.25	4,675	Rising.
16	Apr. 20	7.55	3,862	Falling.
17	Apr. 21	6.65	3,388	Do.
18	Apr. 22	5.96	2,940	Do.
19	Apr. 23	5.46	2,704	Do.
20	Apr. 24	5.88	3,158	Rising.
21	Apr. 27	5.68	3,049	Do.

Daily gage height of Black Warrior River at Tuscaloosa, Ala., for 1889.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec
1	15.00	23.50	18.80	8.50	8.80	2.30	2.40	3.70	0.75	2.40	0.90	6.00
2	19.50	20.50	16.50	9.80	14.50	2.90	3.10	3.60	7.30	1.95	1.05	5.65
3	18.00	17.50	25.00	10.30	13.20	2.75	4.40	3.00	6.40	1.55	1.85	5.30
4	16.00	14.80	31.50	11.60	11.00	2.50	5.10	2.95	5.30	1.30	1.90	4.80
5	25.00	13.00	29.40	10.50	8.50	2.30	6.25	2.90	6.20	1.15	3.85	4.50
6	33.00	11.50	26.50	9.50	7.00	2.10	6.85	3.70	9.30	1.05	3.65	4.20
7	33.50	10.40	23.00	8.40	5.80	1.90	6.45	3.45	14.90	.90	3.30	4.00
8	29.50	9.30	20.10	7.30	4.60	1.70	5.70	2.95	19.00	.70	3.00	3.80
9	26.80	8.30	17.50	6.80	4.30	2.00	4.75	2.60	14.00	.50	2.75	3.60
10	28.40	8.00	15.00	6.40	4.00	2.60	3.85	2.00	9.90	.40	2.55	3.40
11	29.00	7.80	12.80	6.30	3.80	2.85	3.05	1.75	5.50	.30	3.65	3.20
12	25.50	7.60	11.00	6.00	3.20	4.20	2.85	1.55	5.25	.30	4.30	2.95
13	22.50	7.30	10.00	5.60	3.00	3.40	2.45	3.85	4.15	.20	4.15	2.75
14	19.00	7.00	9.20	5.50	3.10	4.00	2.15	3.60	3.30	.15	3.75	2.70
15	16.00	7.30	8.80	8.00	3.20	3.45	1.95	3.35	2.70	.15	3.50	2.65
16	13.60	27.50	8.10	16.80	3.00	3.25	4.20	3.15	2.25	.15	4.20	2.50
17	29.00	49.00	7.20	16.70	2.80	3.05	7.35	3.80	2.00	.10	5.20	2.30
18	40.50	56.40	7.10	14.00	2.50	2.85	11.35	3.50	1.50	.10	12.45	2.20
19	38.50	56.60	11.00	12.00	2.35	2.65	11.50	3.20	1.40	.05	18.90	2.10
20	34.00	53.00	12.50	10.00	2.25	2.45	8.40	2.90	1.30	.05	16.90	2.05
21	30.30	47.00	12.30	8.90	2.05	2.25	4.60	2.40	1.20	.05	14.10	2.00
22	28.10	41.50	11.80	8.00	1.85	3.25	4.55	1.90	1.10	.00	11.70	2.00
23	26.00	36.50	10.80	7.00	1.65	3.45	4.50	1.50	1.00	— .10	9.70	2.00
24	23.10	32.50	10.00	6.40	1.50	3.20	3.70	1.20	1.00	— .30	7.90	2.00
25	21.00	28.50	9.80	6.30	1.30	3.00	3.15	.90	.95	— .15	6.60	1.95
26	20.40	26.50	11.20	6.80	1.25	2.40	3.10	.75	2.25	+ .10	6.30	1.95
27	28.00	23.50	11.80	6.50	1.15	1.95	4.55	1.00	3.70	.35	6.10	1.95
28	33.50	21.40	12.30	6.20	1.05	1.55	4.05	.95	3.50	.35	5.90	1.90
29	33.80	......	11.00	5.80	.95	1.25	4.00	.90	3.25	.40	5.80	1.90
30	30.00	......	10.50	5.50	1.15	1.10	4.00	1.10	2.60	.90	6.30	3.00
31	27.00	......	9.80	......	1.10	....	3.80	1.05	......	1.00	......	4.85

Daily gage height of Black Warrior River at Tuscaloosa, Ala., for 1890.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec
1	7.70	30.20	58.90	24.50	16.70	7.75	1.80	5.00	8.00	9.30	3.75	1.00
2	7.20	26.20	57.40	34.50	13.70	6.50	1.65	4.05	5.80	7.40	3.35	1.00
3	6.20	22.50	52.40	34.10	11.95	5.65	1.45	3.25	4.35	6.10	3.10	1.00
4	5.20	19.05	45.80	43.60	12.75	5.00	1.25	2.85	3.40	5.10	2.85	1.00
5	5.20	16.40	40.85	45.90	14.65	4.40	1.10	3.15	3.10	4.40	2.55	1.00
6	4.80	13.90	37.15	44.50	16.50	4.00	.80	3.35	3.85	3.80	2.40	1.00
7	4.50	12.10	35.40	38.70	15.00	5.20	.60	3.75	4.35	3.50	2.25	1.20
8	4.55	44.30	32.60	34.00	13.50	5.60	.50	4.55	4.80	3.45	2.15	10.05
9	5.10	53.95	30.50	29.95	11.95	5.40	.45	4.30	2.85	4.50	2.05	10.10
10	5.30	52.90	27.50	26.70	10.10	5.25	.30	4.30	3.20	4.45	2.00	8.95
11	5.60	47.50	25.00	23.45	9.30	5.00	.20	6.10	2.90	4.10	1.95	7.10
12	5.45	42.20	23.00	20.45	8.35	6.00	.15	6.40	3.45	3.80	1.75	5.80
13	5.30	37.20	20.75	17.45	8.35	6.20	.05	5.30	3.95	3.50	1.65	4.60
14	5.20	32.65	22.50	14.50	9.00	6.20	1.05	4.50	5.80	3.20	1.60	3.70
15	5.60	29.45	38.20	12.15	8.75	5.60	2.55	3.20	5.55	2.80	1.60	3.30
16	11.20	26.95	38.00	10.65	8.65	5.05	3.10	2.80	4.50	2.70	1.55	2.95
17	19.30	23.95	35.80	10.35	9.50	4.35	3.55	2.50	3.55	2.60	1.65	2.80
18	21.00	21.45	32.30	12.95	8.90	4.30	3.65	2.70	2.90	2.40	1.60	2.75
19	18.40	18.45	29.00	13.20	8.15	4.20	4.15	2.55	2.45	2.30	1.55	2.20
20	15.40	15.65	27.20	13.95	7.95	3.70	4.75	2.40	2.10	2.10	1.50	2.00
21	13.30	13.45	32.40	12.15	7.95	3.20	4.20	2.20	1.75	2.00	1.50	2.00
22	11.60	12.00	34.45	10.45	9.00	2.80	3.00	1.80	1.70	2.45	1.45	1.90
23	10.10	10.40	41.25	9.30	8.40	2.50	2.10	1.40	3.05	4.90	1.35	1.90
24	10.70	9.40	40.25	10.65	7.65	2.25	1.75	1.10	3.10	8.45	1.30	1.80
25	12.50	9.50	36.75	15.45	6.95	2.25	2.75	1.00	13.05	10.55	1.25	1.80
26	13.50	13.50	33.35	26.50	6.85	2.15	12.65	.95	23.90	9.60	1.20	2.30
27	12.80	35.20	29.70	28.45	9.60	2.55	13.40	.95	22.65	8.05	1.15	6.80
28	11.80	53.10	27.45	26.20	13.20	2.25	10.50	5.10	18.00	6.45	1.10	9.70
29	10.60	......	24.55	23.35	13.55	2.05	9.30	9.55	14.70	5.30	1.05	10.20
30	17.60	......	21.95	19.80	11.95	1.90	7.45	9.15	11.90	4.90	1.00	9.10
31	31.70	......	18.80	......	9.25	....	6.50	10.45	......	4.15	......	7.30

Daily gage height of Black Warrior River at Tuscaloosa, Ala., for 1891.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec
1..........	6.10	33.20	24.00	34.00	5.70	1.80	2.10	6.50	1.00	—0.40	—0.80	3.40
2..........	8.60	39.60	23.50	39.40	5.50	1.90	2.00	13.00	1.00	— .30	— .80	3.00
3..........	14.30	40.90	20.50	36.80	5.30	1.80	1.90	14.80	1.00	— .20	— .80	2.40
4..........	17.90	40.20	19.60	32.50	4.90	1.70	1.80	16.00	.80	— .20	— .80	6.20
5..........	15.20	39.30	17.20	28.50	4.50	1.50	1.50	13.00	.70	— .20	— .80	6.80
6..........	13.10	36.30	29.00	25.00	4.50	1.40	1.30	9.50	.60	— .20	— .80	21.50
7..........	11.10	37.00	53.00	22.20	4.20	1.40	1.40	7.40	.60	— .40	— .80	19.50
8..........	10.00	51.50	58.00	19.00	4.00	1.50	2.10	5.80	.60	— .50	— .80	20.00
9..........	9.50	51.50	60.40	16.00	3.90	2.10	7.00	5.40	.60	— .60	— .80	20.50
10..........	17.50	52.20	58.00	14.20	3.50	2.80	10.40	3.70	.60	— .70	+ .70	17.00
11..........	20.90	53.50	54.00	17.20	3.20	3.50	8.20	3.10	.70	— .80	2.10	14.00
12..........	26.30	50.50	48.00	27.00	3.20	10.20	6.00	2.70	1.00	— .80	2.80	11.60
13..........	30.10	47.60	43.00	26.00	3.10	10.50	4.30	2.50	1.20	— .80	4.40	9.00
14..........	25.50	51.40	40.00	22.50	3.00	9.80	3.20	3.00	1.20	— .80	3.80	6.20
15..........	21.00	49.50	36.50	19.50	2.80	8.00	2.30	3.40	1.00	— .60	2.50	7.00
16..........	18.50	46.50	33.20	17.20	2.60	6.50	2.60	4.00	1.00	— .70	2.00	9.00
17..........	17.10	44.30	30.00	15.60	2.50	5.60	2.60	3.00	.60	— .70	1.80	11.00
18..........	17.70	41.00	28.00	16.40	2.50	6.30	2.90	2.60	.20	— .70	1.80	11.20
19..........	17.10	37.50	26.40	14.50	2.50	7.20	2.50	2.20	.10	— .60	1.50	10.00
20..........	15.60	35.00	24.00	13.40	2.50	7.00	2.20	2.00	.10	— .70	1.30	8.50
21..........	12.60	33.50	21.00	12.00	2.50	6.00	1.80	1.50	.10	— .70	1.40	7.00
22..........	20.20	39.50	19.90	11.00	2.70	5.50	1.60	1.50	.10	— .60	3.00	6.00
23..........	31.60	41.00	17.50	10.00	3.00	5.20	1.40	1.40	.10	— .60	8.00	6.00
24..........	31.80	39.00	15.00	9.00	3.00	4.80	1.30	1.30	.10	— .50	12.30	6.20
25..........	30.10	36.50	12.50	8.20	2.80	4.50	1.40	1.20	.00	— .60	13.30	7.50
26..........	30.70	33.00	12.10	7.60	2.60	4.20	2.60	1.10	.00	— .50	10.80	13.20
27..........	29.00	29.00	15.00	8.40	2.50	4.10	2.00	1.10	— .20	— .70	7.20	31.00
28..........	26.80	26.50	18.20	8.00	2.40	3.70	2.20	1.00	— .20	— .80	5.80	38.90
29..........	23.70	......	19.40	7.30	2.30	2.90	2.00	1.00	— .40	— .80	4.20	31.20
30..........	32.70	......	18.00	6.50	2.10	2.50	2.10	1.10	— .50	— .80	3.80	27.00
31..........	33.00	......	17.00	......	2.00	......	2.40	1.00	......	— .80	......	22.10

Daily gage height of Black Warrior River at Tuscaloosa, Ala., for 1892.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec
1..........	17.90	21.20	10.70	21.80	12.00	3.40	4.60	4.80	9.30	3.90	0.40	5.90
2..........	15.90	10.50	10.30	18.30	11.20	3.20	3.90	3.20	7.60	3.50	.40	5.60
3..........	18.50	9.40	9.70	15.50	9.90	3.50	3.40	7.00	6.50	3.30	1.20	5.30
4..........	18.70	8.50	8.80	15.20	8.80	3.70	3.00	7.40	5.60	3.10	1.60	4.90
5..........	16.40	7.80	8.00	12.00	7.20	3.50	2.90	6.60	4.90	2.80	1.60	6.30
6..........	14.60	7.40	7.80	11.60	6.50	4.70	3.50	5.40	4.90	2.50	1.60	7.50
7..........	13.00	7.80	8.00	56.30	5.90	5.00	5.20	4.80	4.80	2.40	2.00	7.50
8..........	11.60	7.50	16.50	63.20	5.30	4.90	11.00	3.90	6.40	2.20	3.90	12.20
9..........	10.80	9.00	26.80	62.20	5.20	4.10	26.70	3.60	6.20	2.10	4.60	15.00
10..........	10.50	16.00	28.50	58.00	4.90	4.00	43.50	3.50	5.40	2.00	8.90	13.20
11..........	25.70	13.00	26.70	52.30	4.90	3.80	46.20	3.00	5.10	2.00	10.90	11.00
12..........	34.80	11.30	22.00	45.40	4.80	3.50	41.40	3.00	3.90	2.00	8.30	9.40
13..........	53.00	10.80	18.00	40.70	4.70	3.30	38.30	3.30	3.40	2.00	7.60	8.00
14..........	57.40	9.50	15.80	36.50	4.60	2.80	37.50	3.10	3.30	1.90	5.80	7.40
15..........	55.90	9.00	13.80	32.80	4.50	2.50	34.80	3.90	4.00	1.90	5.00	8.60
16..........	51.70	10.00	13.30	29.50	4.00	2.40	32.80	3.50	5.10	1.90	4.50	10.30
17..........	45.00	11.80	11.20	27.00	3.70	2.00	41.40	3.50	4.90	1.80	4.00	13.10
18..........	40.10	11.00	12.90	24.50	3.60	1.80	38.00	6.00	4.30	1.70	4.20	26.70
19..........	36.60	9.90	24.00	22.40	4.30	2.10	33.00	9.50	6.00	1.00	4.40	28.40
20..........	41.50	10.50	25.50	20.20	4.60	3.90	29.00	11.50	18.30	1.00	4.70	28.40
21..........	41.00	13.50	22.90	18.10	6.50	7.40	25.30	9.50	23.90	.90	5.00	36.50
22..........	36.80	18.00	20.00	15.90	6.30	10.80	29.30	7.40	20.90	.90	4.80	35.80
23..........	34.40	23.90	18.30	13.80	6.00	10.70	25.10	10.20	17.00	.90	4.50	31.50
24..........	31.00	21.20	22.00	12.30	6.00	8.40	21.50	12.30	13.30	1.00	4.20	27.00
25..........	28.50	18.50	29.00	11.30	4.80	7.80	18.80	14.00	10.50	1.00	3.80	23.00
26..........	26.00	16.00	32.00	10.50	3.50	7.90	15.80	14.20	8.00	.90	3.50	19.50
27..........	23.80	14.00	35.80	8.80	4.70	7.20	13.00	13.20	6.10	.80	3.30	16.00
28..........	21.50	12.50	34.00	7.90	4.00	6.10	10.50	11.50	5.00	.70	3.20	13.60
29..........	19.00	11.50	30.50	7.70	3.80	5.20	7.80	12.00	4.90	.70	3.90	11.40
30..........	16.80	......	26.80	10.50	3.50	5.40	6.20	11.50	4.30	.50	5.90	9.80
31..........	14.00	......	23.90	......	3.50	.....	5.50	10.50	......	.50	......	8.50

Daily gage height of Black Warrior River at Tuscaloosa, Ala., for 1893.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec
1..........	8.20	18.10	23.00	9.40	24.50	12.50	2.50	0.60	0.30	1.10	0.40	1.50
2..........	8.60	15.90	21.70	9.30	21.20	33.50	2.50	.70	.20	1.00	.40	1.50
3..........	9.80	14.00	19.70	9.00	30.00	49.60	2.80	1.00	.10	1.20	.40	1.80
4..........	10.70	12.80	20.50	8.70	51.20	46.00	3.60	1.20	.00	1.40	.40	2.80
5..........	10.10	12.50	23.00	8.00	52.20	39.00	3.60	1.30	— .10	1.30	.40	3.50
6..........	9.00	11.80	24.00	8.70	48.00	37.70	3.20	1.20	— .10	1.20	.40	4.20
7..........	8.40	11.20	22.60	9.30	42.90	39.90	2.70	1.30	.00	1.20	.40	4.10
8..........	7.90	10.80	20.10	9.00	40.40	39.30	2.40	1.20	+ .20	1.20	.40	3.50
9..........	7.00	10.60	20.00	8.30	37.40	34.00	2.10	1.00	1.40	1.00	.40	3.00
10..........	6.70	10.20	22.00	7.60	34.30	29.20	1.80	.90	2.00	.90	.60	2.80
11..........	6.20	12.00	21.80	7.00	30.80	25.10	1.60	.90	2.10	.80	.60	2.30
12..........	6.50	23.90	20.50	6.40	27.50	21.20	1.60	.80	2.20	.80	.50	1.90
13..........	7.80	28.30	19.30	6.10	24.40	17.40	2.20	.90	3.20	.80	.50	1.70
14..........	9.00	27.00	18.10	5.80	21.90	14.70	2.60	3.60	4.30	.70	.60	1.60
15..........	9.60	25.90	16.30	23.00	19.10	11.60	2.40	4.90	4.30	.70	.60	1.50
16..........	11.40	52.20	14.70	27.10	16.20	9.60	2.00	5.10	3.90	.60	.60	1.70
17..........	12.20	55.60	13.20	24.00	14.00	7.60	1.70	4.70	3.30	.50	.60	2.30
18..........	11.80	54.70	12.20	20.00	11.90	6.70	1.40	3.70	2.50	.50	.60	2.40
19..........	12.00	51.40	11.30	16.40	11.00	6.50	1.30	2.80	2.10	.50	.60	2.30
20..........	12.40	46.50	10.70	13.90	8.40	6.90	1.20	2.20	1.80	.50	.60	2.10
21..........	11.80	41.80	9.90	12.00	6.90	6.90	1.20	1.70	1.40	.50	.70	2.50
22..........	10.90	37.90	9.30	11.20	6.20	6.60	1.30	1.50	1.30	.50	1.00	2.40
23..........	11.20	34.50	8.80	10.70	5.60	6.40	1.60	1.30	1.20	.40	1.00	2.30
24..........	12.90	31.30	12.30	9.90	5.10	5.70	1.70	1.10	1.00	.40	1.10	2.10
25..........	15.90	28.40	22.20	8.90	4.80	4.90	1.50	1.00	1.30	.40	1.00	1.90
26..........	19.20	25.90	22.50	7.00	4.50	4.40	1.30	.90	1.20	.40	.90	1.70
27..........	22.00	23.80	20.00	10.50	4.30	4.00	1.20	.80	1.20	.40	1.00	1.60
28..........	23.30	23.00	17.00	32.50	5.10	3.50	.90	.80	1.10	.40	1.70	1.50
29..........	23.10	......	14.40	33.90	6.10	3.10	.90	.60	1.10	.40	1.70	1.40
30..........	22.10	......	12.40	29.00	12.90	2.80	.80	.50	1.10	.40	1.50	3.70
31..........	20.40	......	10.90	......	14.10	....	.80	.20	......	.40	......	7.60

Daily gage height of Black Warrior River at Tuscaloosa, Ala., for 1894.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec
1..........	10.30	8.50	27.00	11.40	6.50	1.70	2.50	1.20	5.80	0.55	—0.05	—.05
2..........	9.60	7.80	25.60	14.10	5.90	1.60	1.80	1.30	4.60	.45	— .10	—.05
3..........	7.90	7.30	23.60	23.50	5.90	1.50	1.35	1.40	3.60	.40	— .20	.00
4..........	6.20	7.90	21.00	24.00	5.80	1.35	1.10	1.95	2.95	.32	— .25	.00
5..........	5.40	16.90	18.20	22.20	5.50	1.33	.80	2.30	2.45	.25	— .30	.00
6..........	6.40	22.60	15.90	20.60	5.20	1.20	.60	2.40	2.05	.20	— .30	.00
7..........	16.80	20.40	14.80	18.90	5.10	1.20	1.00	2.00	1.85	.15	— .30	.00
8..........	22.60	17.80	14.40	16.30	4.90	1.10	1.30	1.60	1.75	.00	— .30	+.05
9..........	19.70	17.30	13.80	14.70	4.50	.95	.70	1.30	1.65	— .10	— .30	.05
10..........	26.90	26.00	12.60	15.70	4.10	.90	.70	1.10	1.60	— .20	— .30	.50
11..........	34.50	27.80	11.60	25.00	3.70	.80	.60	.80	1.85	— .25	— .30	2.10
12..........	35.80	25.40	11.50	25.10	3.90	.80	.60	.70	3.40	— .30	— .30	5.70
13..........	30.90	29.90	16.50	22.70	4.30	.70	.50	.60	5.60	— .30	— .30	10.40
14..........	25.80	32.10	17.30	19.50	7.00	.60	.50	.50	7.50	— .30	— .10	11.20
15..........	22.20	29.70	15.80	16.30	6.20	.60	.60	.35	5.70	— .30	.00	8.90
16..........	23.60	26.00	15.50	15.50	5.70	.60	.70	.60	4.20	— .30	+ .05	6.40
17..........	24.80	22.30	33.10	16.00	5.10	.55	.75	.55	3.25	— .30	.05	4.90
18..........	22.40	19.10	36.70	17.00	5.00	.50	.70	.45	3.50	— .30	.05	3.90
19..........	19.30	16.80	33.70	25.30	4.70	.60	.70	.40	3.25	— .30	.00	3.20
20..........	15.90	16.00	29.50	24.80	4.20	.70	.60	.55	3.25	— .30	— .10	2.90
21..........	14.10	16.90	27.80	24.00	3.60	.85	.50	1.00	4.10	— .30	— .10	2.60
22..........	18.60	17.90	29.30	20.40	3.10	.80	.90	1.35	3.60	— .30	— .10	2.20
23..........	21.30	17.00	29.60	17.30	2.80	.95	1.30	3.80	2.90	— .30	— .10	2.00
24..........	19.90	16.10	28.00	14.20	2.60	1.10	1.35	5.30	2.20	— .35	.00	1.80
25..........	17.60	17.30	27.80	12.20	2.40	1.00	1.60	9.20	1.75	— .40	.00	1.70
26..........	15.50	29.30	25.30	10.50	2.30	1.05	1.50	16.00	1.45	— .40	.00	2.00
27..........	14.00	31.00	22.10	9.80	2.10	1.40	1.40	20.40	1.20	— .45	— .05	7.70
28..........	12.40	28.80	19.00	8.70	2.10	1.70	1.30	16.00	1.05	— .45	— .05	9.70
29..........	11.10	......	16.10	7.90	2.00	2.35	.20	11.80	.90	— .45	— .05	8.40
30..........	10.00	......	14.30	7.00	1.90	2.60	1.10	8.30	.70	— .20	— .05	7.20
31..........	9.10	......	12.70	......	1.90	....	1.20	6.80	......	— .05	— .05	6.50

Daily gage height of Black Warrior River at Tuscaloosa, Ala., for 1895.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec
1	6.10	24.10	8.60	16.20	15.20	7.00	4.80	1.80	1.90	0.10	—0.04	0.75
2	5.40	21.50	13.20	14.50	13.00	5.90	4.50	1.50	1.80	.00	+ .07	.95
3	6.80	21.40	35.30	12.60	11.00	5.10	5.40	1.30	1.80	— .07	.12	1.05
4	9.00	21.40	36.70	11.00	9.40	4.60	7.60	1.20	1.70	— .10	.09	1.00
5	8.80	19.90	32.40	10.20	8.30	4.20	17.40	1.20	1.90	— .10	.11	.90
6	8.00	17.90	27.80	8.40	7.40	6.70	17.70	1.20	2.60	— .10	.25	1.30
7	7.40	16.50	23.80	7.90	7.00	5.70	18.40	1.10	3.05	— .10	.31	1.50
8	35.00	16.80	20.60	20.50	8.20	5.10	15.70	1.00	3.70	.00	.30	1.45
9	50.60	16.90	20.10	24.00	13.50	4.30	13.10	.90	3.40	— .03	.28	1.90
10	49.30	15.80	19.30	21.20	19.70	3.80	11.10	.97	2.90	— .07	.70	1.80
11	45.10	14.60	17.50	18.00	23.30	3.10	9.80	1.40	2.40	— .10	1.20	1.45
12	40.10	14.10	17.20	15.10	22.00	2.70	7.90	1.50	2.20	— .14	1.10	1.40
13	35.00	13.90	18.40	12.60	18.50	2.40	6.50	1.40	2.10	— .14	1.18	1.40
14	29.80	12.80	24.90	11.00	15.20	2.20	5.30	1.30	2.00	+ .06	1.35	1.37
15	25.70	11.60	37.50	9.50	12.20	2.00	5.40	1.10	1.80	.04	1.35	1.33
16	23.40	10.50	47.40	8.60	9.70	2.00	5.60	1.30	1.60	— .08	1.28	1.23
17	31.20	9.40	52.00	10.00	8.00	2.70	5.90	1.40	1.40	— .18	1.20	1.12
18	32.90	9.00	47.30	15.90	6.90	3.30	5.80	2.00	1.40	— .27	1.05	1.05
19	29.20	9.00	42.10	15.80	6.30	4.20	5.10	4.00	1.30	— .31	.88	1.02
20	25.80	9.50	38.80	14.00	5.90	4.90	4.60	4.30	1.00	— .37	.82	1.57
21	23.10	10.20	48.70	12.00	5.30	4.70	4.00	3.60	1.20	— .42	.70	2.55
22	21.60	10.90	51.30	10.40	4.80	4.30	3.60	2.80	1.50	— .45	.60	2.60
23	21.60	11.40	47.60	8.90	4.30	4.10	3.40	2.40	1.30	— .50	.50	3.08
24	19.80	11.30	42.10	8.00	4.10	3.70	3.30	4.30	1.10	— .35	.75	3.65
25	17.40	10.90	37.30	7.20	4.00	3.40	3.60	4.90	.80	— .33	.60	3.31
26	16.70	10.30	32.80	7.00	4.30	3.00	3.70	4.00	.60	— .53	.38	4.50
27	20.00	9.70	29.10	7.10	5.60	4.40	3.30	3.20	.35	— .70	.64	10.40
28	21.20	9.00	26.10	12.50	11.00	5.40	2.90	2.40	.10	— .68	.65	21.02
29	22.00	......	23.60	15.00	13.30	6.00	2.40	2.30	.50	— .67	.65	16.88
30	27.40	......	21.10	16.40	11.20	5.40	2.00	2.10	.30	— .50	.60	13.10
31	27.10	......	18.60	......	8.90	....	2.10	2.00	......	— .32	......	11.67

Daily gage height of Black Warrior River at Tuscaloosa, Ala., for 1896.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec
1	11.41	7.92	6.91	10.61	18.24	4.92	1.94	.53	.38	— .52	— .78	7.70
2	10.26	8.51	7.66	14.78	33.30	4.28	1.71	.80	.25	— .62	— .77	6.32
3	8.90	21.98	7.41	23.00	37.18	3.50	1.44	1.34	.15	— .66	— .42	4.68
4	7.60	33.12	6.74	23.50	30.88	5.44	1.48	.89	.05	— .20	— .39	3.40
5	6.55	30.02	6.14	19.85	26.40	5.24	1.30	.54	— .06	+ .78	— .33	2.60
6	5.74	30.75	6.64	16.70	21.93	4.30	1.15	.42	— .15	.74	— .19	2.05
7	5.09	35.92	10.18	14.26	17.88	3.62	1.32	.50	— .23	.68	— .19	1.70
8	5.24	35.08	12.04	12.55	13.96	3.27	2.20	.60	— .30	.40	— .17	1.47
9	5.76	36.21	14.89	11.20	10.80	6.60	8.40	.68	— .37	.09	— .18	1.21
10	6.46	36.52	13.69	10.02	8.60	8.18	6.98	.64	— .44	— .15	— .21	1.10
11	6.58	33.65	12.45	9.04	7.11	18.39	5.37	.55	— .44	— .28	— .30	.89
12	6.25	29.45	13.97	8.33	6.09	15.13	3.95	.45	— .46	— .28	— .20	.84
13	5.79	25.97	16.15	7.62	5.34	10.77	2.99	.38	— .50	— .48	— .22	.80
14	5.26	27.41	15.35	7.86	4.77	7.66	2.45	.35	— .60	— .49	— .11	.75
15	4.82	33.25	13.56	11.65	6.13	5.60	2.16	.31	— .59	— .46	— .10	1.20
16	4.87	31.02	13.86	13.90	5.45	4.33	2.13	.26	— .59	— .43	— .01	1.25
17	6.03	27.30	22.30	12.36	4.65	4.74	2.15	.13	— .60	— .60	+ .26	1.25
18	8.61	23.65	27.75	10.57	3.94	4.20	2.42	.40	— .60	— .63	.46	1.60
19	9.14	20.09	29.70	9.03	3.44	6.18	2.46	.50	— .60	— .78	.52	1.90
20	8.53	17.00	37.68	7.81	3.05	6.00	2.24	.40	— .61	— .82	.45	1.70
21	7.87	14.45	37.92	6.88	2.91	5.32	2.16	.34	— .64	— .82	.39	1.50
22	8.85	12.20	33.55	6.15	2.77	4.91	1.90	.29	— .64	— .84	.38	1.33
23	22.47	10.32	29.12	5.56	2.87	4.46	1.71	.22	— .36	— .84	.38	1.20
24	29.26	9.13	25.85	5.67	2.90	4.19	2.06	1.06	— .45	— .78	.37	.98
25	26.52	8.60	23.54	5.76	2.87	4.04	2.53	.95	— .61	— .80	.37	.92
26	22.44	8.35	21.28	5.30	2.97	3.37	2.17	.79	— .64	— .82	.37	.77
27	18.55	7.90	18.72	5.26	3.66	2.85	1.70	.77	— .71	— .82	.98	.71
28	14.92	7.40	16.35	10.47	3.59	2.69	1.28	1.35	— .76	— .78	.09	.59
29	12.14	7.00	14.30	16.06	6.52	2.54	.94	1.30	— .67	— .80	.83	.52
30	10.18	......	12.69	14.18	6.50	2.21	.76	.95	— .55	— .80	1.00	.48
31	8.88	......	11.40	......	5.78	....	.64	.60	......	— .78	......	.48

The following discharge measurement was made by B. M. Hall in 1897, at Tuscaloosa, Ala.:

January 12, gage height, 1.70 feet; discharge, 829 second-feet.

Daily gage height of Black Warrior River at Tuscaloosa, Ala., for 1897.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.34	3.90	11.14	13.90	9.51	1.83	—0.15	1.36	0.60	—1.65	—1.39	—1.28
2	.47	6.00	9.57	15.28	9.95	1.75	— .18	1.08	.96	—1.71	—1.30	—1.12
3	.40	11.50	8.58	22.20	9.22	1.70	— .20	.87	1.02	—1.72	—1.29	— .48
4	.90	12.60	8.72	21.11	7.66	2.01	— .18	.62	.92	—1.75	—1.31	+1.29
5	1.24	11.70	10.14	22.00	6.23	1.98	— .05	.50	.76	—1.79	—1.33	13.10
6	1.11	12.37	16.33	26.95	5.36	2.65	1.63	.40	.62	—1.86	—1.28	14.24
7	1.40	16.24	51.42	25.32	4.67	3.44	3.40	.25	.51	—1.79	—1.27	10.72
8	2.60	18.70	54.77	22.10	4.20	2.87	3.90	.24	.47	—1.85	—1.27	7.39
9	2.66	21.04	51.59	21.30	3.87	2.25	3.71	1.10	.42	—1.88	—1.17	5.12
10	2.30	19.80	44.69	29.27	3.50	1.85	3.05	2.10	.36	—1.90	—1.13	3.72
11	2.03	17.90	40.54	29.57	3.20	1.60	2.53	3.26	.29	—1.90	—1.10	3.05
12	1.76	23.42	42.53	25.48	3.64	1.39	2.42	3.22	.23	—1.88	—1.14	2.70
13	1.52	25.90	48.70	21.60	11.40	1.24	2.16	2.73	.14	—1.89	—1.17	2.56
14	1.33	23.84	50.96	18.10	20.36	1.11	1.86	2.27	.11	—1.92	—1.25	3.05
15	1.23	20.30	48.57	16.32	20.46	.95	1.46	1.63	.10	—1.92	—1.25	3.54
16	8.23	16.96	45.20	18.43	16.59	.85	1.16	1.28	.06	—1.92	—1.27	4.12
17	9.70	14.04	47.21	18.33	12.68	.75	.97	1.00	.01	—1.90	—1.33	4.10
18	13.10	11.72	46.72	15.92	9.77	.63	1.50	.73	— .05	—1.90	—1.35	3.78
19	19.35	9.97	42.90	13.66	7.73	1.30	3.50	.52	— .36	—1.90	—1.36	3.50
20	18.70	8.77	42.57	11.86	6.35	1.46	12.50	1.53	— .75	—1.88	—1.36	3.82
21	17.43	8.08	44.54	10.45	5.37	1.11	14.50	1.78	— .95	—1.88	—1.36	6.70
22	18.64	8.32	41.50	9.24	4.66	.80	11.30	1.58	—1.07	—1.77	—1.37	10.58
23	16.52	11.00	37.70	8.15	4.13	.55	8.42	1.33	—1.17	—1.64	—1.42	31.00
24	13.30	20.20	35.66	7.37	3.70	.33	6.64	1.08	—1.26	—1.58	—1.44	29.96
25	10.60	21.24	32.40	6.80	3.45	.23	4.77	1.27	—1.24	—1.63	—1.40	24.68
26	8.60	18.97	28.86	6.37	3.13	.16	3.46	.97	—1.36	—1.63	—1.36	18.97
27	7.20	16.18	25.60	5.90	2.90	.12	2.72	.80	—1.41	—1.61	—1.36	15.67
28	6.00	13.31	23.15	5.49	2.60	.03	2.92	.61	—1.44	—1.64	—1.28	13.10
29	5.10	......	20.33	5.10	2.28	.00	2.15	.54	—1.50	—1.61	—1.29	11.00
30	4.42	......	17.52	5.90	2.09	— .08	1.80	.46	—1.55	—1.63	—1.24	9.38
31	3.80	......	14.98	......	2.00	....	1.62	.31	......	—1.63	......	8.00

Daily gage height of Black Warrior River at Tuscaloosa, Ala., for 1898.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec
1..........	7.10	21.68	3.67	25.50	11.34	0.23	0.66	2.45	1.20	—0.60	0.90	5.40
2..........	6.28	18.30	3.78	22.40	9.82	.08	.43	1.95	.82	— .70	.70	5 50
3..........	5.52	14.90	4.03	18.50	8.67	.23	.30	2.45	.70	— .80	.60	5.40
4..........	4.96	12.12	4.05	15.31	7.68	.27	.53	2.80	.30	— .90	.40	5.00
5..........	4.41	10.15	3.98	20.82	6.88	.27	.16	2.96	.00	—1.00	.00	4.70
6..........	4.17	9.42	3.90	38.70	6.20	.15	.10	3.90	— .10	— .90	.30	4.50
7..........	4.13	8.90	3.57	38.55	5.59	02	— .18	3.40	— .30	— .90	.50	5.00
8..........	4.18	8.43	3.33	32.83	5.00	—.10	— .04	3.10	— .20	— .70	.40	5.00
9..........	4.17	7.84	3.12	27.70	4.50	—.29	— .04	3.98	.00	— .30	.40	4.70
10..........	3.97	7.30	3.00	23.04	4.20	—.41	+ .10	6.20	.20	+2.00	.50	4 20
11..........	4.00	6.68	2.90	19.50	3.91	—.54	.08	12.20	.40	3.30	.50	3.70
12..........	4.18	6.30	2.83	17.03	3.50	—.62	— .07	14.10	.20	2.60	.40	3.30
13..........	6.70	6.20	2.80	15.01	3.21	—.71	— .10	10.60	.00	2.00	.50	3.00
14..........	9.70	6.08	3.00	12.93	2.88	—.62	— .07	7.30	— .30	1.40	.80	2.80
15..........	11.97	5.86	4.80	11.65	2.58	—.53	— .11	5.00	— .30	1.00	1.10	2.60
16..........	11.71	5.40	8.00	10.78	2.30	—.38	— .07	3.50	— .40	.80	1.30	2.50
17..........	15.00	5.00	15.40	9.60	2.08	—.48	— .14	2.62	— .60	.40	1.50	2 40
18..........	15.53	4.90	14.10	8.63	1.97	—.56	.00	1.91	— .70	.80	1.60	2.10
19..........	14.32	4.83	11.92	8.15	1.64	—.30	1.24	1.50	— .70	.80	1.90	4.40
20..........	24.50	4.84	10.08	27.80	1.43	—.21	1.30	1.46	— .80	1.20	2.20	18.80
21..........	33.54	4.70	8.82	33.11	1.23	.00	1.12	1.12	— .90	3.10	2.50	23.90
22..........	31.42	4.48	7.80	28.45	1.07	.07	.88	1.26	— .50	3.80	4.00	21.30
23..........	28.50	4.30	6.96	23.77	1.00	.18	.47	1.20	— .60	4.10	8.60	17.40
24..........	30.38	4.00	6.30	22.72	.93	.30	1.08	.90	— .70	4.80	11.70	13.30
25..........	30.12	3.83	6.00	24.04	.78	.17	1.95	.50	— .80	4.30	11.60	10.50
26..........	42.50	3.64	5.90	22.62	.57	.06	2.50	1.10	— .90	3.90	9.50	8.60
27..........	43.48	3.[illegible]	5.53	19.67	.43	1.30	2.00	1.02	— .90	2.90	7.40	7.30
28..........	39.41	3.72	5.12	17.12	.43	1.10	1.80	.98	— .80	2.30	5.90	6.20
29..........	33.80	......	5.23	15.05	.52	.46	2.03	1.30	— .80	2.00	5.50	5.60
30..........	28.50	......	13.40	13.03	.44	.68	2.55	1.52	— .60	1.40	5.30	5.00
31..........	24.90	......	25.68	......	.30	.....	2.86	1.56	......	1.10	....	4.70

The following measurements were made by B. M. Hall, and Prof. George S. Wilkins, of the Alabama University, in 1899:

Measurements of Black Warrior River at Tuscaloosa, Ala.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
February 21..........	19.36	12,855	March 4...............	23.70	12,609
February 21..........	19.25	12,640	March 14...............	31.18	36,653
February 24..........	22.85	16,216	March 14...............	34.37	40,331
February 28..........	39.47	48,010	March 17...............	59.50	119,538
March 1...............	35.50	24.988	March 18...............	56.40	86,410
March 2...............	30.35	18,052	March 23...............	40.30	23,911

Daily gage height of Black Warrior River at Tuscaloosa, Ala., for 1899.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec
1..........	4.40	26.10	37.70	30.30	7.90	2.00	0.10	6.50	1.20	—1.50	—1.03	4.83
2..........	4.50	29.50	32.00	29.20	7.00	1.50	.80	4.90	.70	—1.61	—1.02	3.50
3..........	4.60	27.00	27.70	24.80	6.30	1.20	.30	3.40	.62	—1.80	—1.03	2.77
4..........	4.70	29.00	24.10	22.00	5.80	1.00	— .70	2.70	.23	—1.79	— .99	2.03
5..........	4.70	45.50	21.00	23.20	5.30	1.00	— .10	2.00	— .02	—1.51	—1.00	1.50
6..........	11.20	50.60	20.80	22.60	4.80	.90	— .30	1.90	— .17	—1.48	—1.02	1.22
7..........	42.50	51.40	19.60	23.30	4.40	1.00	— .20	1.80	— .38	—1.46	—1.03	.98
8..........	49.30	51.70	16.90	33.90	4.40	.80	— .30	1.30	— .40	—1.34	—1.03	.88
9..........	46.60	48.60	14.40	34.00	7.60	.40	— .40	1.20	— .46	—1.30	—1.03	.58
10..........	40.40	43.10	12.90	30.80	6.50	.40	— .40	1.10	— .68	— .96	—1.01	.60
11..........	33.70	37.80	11.90	27.00	5.10	.50	— .40	2.00	— .73	— .78	—1.01	2.20
12..........	31.90	32.80	11.30	23.60	4.30	.50	— .50	1.70	— .79	— .72	— .98	23.50
13..........	28.00	28.80	10.00	20.10	4.20	.50	— .60	1.30	— .71	— .70	— .96	39.53
14..........	25.00	25.70	28.80	17.20	4.30	.50	— .60	.90	— .73	— .88	— .98	35.71
15..........	22.20	22.90	44.50	14.90	4.70	.50	— .70	.60	— .78	— .94	— .99	26.50
16..........	20.00	21.60	59.30	13.00	4.30	.70	— .70	.40	— .83	—1.03	—1.00	20.63
17..........	19.60	19.90	60.30	11.60	3.70	.60	— .70	.30	— .86	—1.07	— .97	15.21
18..........	20.10	20.10	57.70	10.50	3.30	.40	— .70	.30	— .88	—1.12	— .97	10.83
19..........	18.60	20.80	52.40	9.80	2.80	.30	— .70	.60	— .90	—1.16	— .95	8.02
20..........	16.10	20.60	49.30	9.60	2.70	.20	— .70	.60	— .92	—1.12	— .95	8.09
21..........	14.00	19.60	46.80	9.50	3.70	.10	— .60	.70	— .94	—1.10	— .92	9.63
22..........	12.20	18.50	41.60	8.70	3.80	.40	— .50	1.50	— .99	— .84	— .89	10.80
23..........	11.00	22.70	36.80	8.60	3.30	—.10	— .20	2.60	—1.03	— .73	— .33	10.63
24..........	11.00	23.10	33.00	11.30	3.10	—.10	+ .60	2.50	—1.05	— .71	+ .17	22.01
25..........	20.30	20.90	29.50	13.60	2.70	—.60	4.90	2.60	—1.04	— .88	.88	29.04
26..........	29.30	18.50	26.50	13.20	2.30	+.20	7.60	2.30	—1.05	— .94	2.60	25.91
27..........	26.20	23.50	24.20	12.60	2.00	.20	7.40	2.10	—1.04	—1.02	4.50	20.98
28..........	22.50	39.00	22.30	11.40	1.75	.20	7.90	1.90	—1.18	— .60	10.48	17.09
29..........	18.60	......	21.10	10.00	1.50	.20	9.50	1.60	—1.28	— .73	9.40	[illegible]
30..........	15.70	......	19.30	8.90	1.60	.10	9.30	1.50	—1.38	— .96	6.67	14.62
31..........	14.80	......	18.10	......	2.50	...	8.50	1.10	......	—1.03	......	12.51

Daily gage height of Black Warrior River at Tuscaloosa, Ala., for 1900.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec
1..........	10.90	6.92	18.14	21.55	21.23	4.24	41.00	9.85	5.50	0.75	4.20	12.50
2..........	9.48	6.40	25.44	18.60	18.95	5.30	33.88	8.00	5.00	.80	5.10	9.65
3..........	8.32	5.00	26.00	15.80	16.33	13.95	32.27	6.50	4.07	.60	5.40	8.50
4..........	7.10	5.71	23.30	13.60	13.82	15.16	32.13	5.15	4.30	.25	5.55	7.90
5..........	6.18	6.40	20.29	12.27	11.60	20.98	30.96	4.40	3.58	.40	5.05	8.20
6..........	5.53	9.58	17.43	12.17	9.60	21.50	27.31	3.80	2.80	.40	4.45	10.20
7..........	5.12	11.50	15.34	11.44	8.20	20.92	23.70	3.35	2.30	.80	3.90	10.65
8..........	4.84	10.53	27.58	10.29	7.28	21.75	20.80	3.00	1.90	1.80	3.50	9.65
9..........	4.60	12.23	39.00	9.97	6.80	28.52	18.45	2.50	1.50	3.90	3.10	[illegible]
10..........	4.50	20.60	36.03	10.58	6.50	31.70	15.96	2.30	1.40	6.05	2.90	8.15
11..........	7.12	23.00	31.63	26.35	6.12	24.73	12.96	2.10	1.10	6.10	2.70	7.50
12..........	31.63	20.64	27.34	52.79	5.90	19.60	11.05	2.00	.90	14.30	2.50	6.90
13..........	31.80	41.37	23.78	53.40	5.48	15.95	10.60	1.75	.80	22.50	2.40	6.45
14..........	28.18	47.96	20.43	48.69	4.98	15.60	12.90	1.50	1.40	21.85	2.25	6.40
15..........	24.09	45.73	17.40	42.30	4.50	19.23	10.35	1.40	5.45	16.40	2.20	6.65
16..........	20.12	40.23	16.63	37.10	3.85	29.15	8.50	1.50	10.65	11.60	2.10	6.45
17..........	16.50	34.74	21.18	63.00	3.65	28.89	7.00	1.48	8.95	8.20	2.05	6.10
18..........	14.28	29.75	20.28	64.05	3.50	25.33	6.00	1.40	6.34	6.13	2.00	5.75
19..........	15.80	25.88	18.80	62.17	3.52	24.51	5.60	3.00	4.44	5.10	1.95	5.30
20..........	25.00	22.43	45.10	59.35	3.39	30.10	6.35	4.40	3.35	4.30	3.90	5.45
21..........	32.60	19.90	51.00	56.10	3.65	27.80	8.50	3.75	2.60	3.60	8.40	6.30
22..........	29.44	23.58	47.98	51.71	3.50	25.38	8.00	3.00	2.20	3.15	10.25	8.35
23..........	24.54	26.50	42.40	46.20	3.35	24.55	8.10	2.50	1.87	4.60	12.50	11.90
24..........	20.43	24.20	38.24	41.88	4.40	50.00	8.70	2.55	1.65	7.30	11.00	17.00
25..........	17.12	22.38	35.41	37.94	7.55	58.35	7.40	2.10	1.60	10.40	9.45	18.70
26..........	14.12	21.00	36.78	33.94	7.68	56.35	6.80	4.48	1.45	8.55	15.90	17.00
27..........	12.14	18.63	35.33	30.89	6.70	52.90	9.20	4.30	1.30	6.75	22.20	[illegible]
28..........	10.47	16.52	31.80	28.15	5.30	49.05	16.20	3.25	1.05	5.40	21.00	12.50
29..........	9.10	......	28.85	25.73	4.25	48.25	13.50	2.40	.90	4.70	17.35	10.95
30..........	8.27	......	26.25	23.50	3.60	[illegible]	11.83	2.10	.75	4.10	14.00	10.15
31..........	7.60	......	24.20	......	3.62	.....	11.05	2.50	......	3.70	......	14.20

During 1901 the following discharge measurements were made on Black Warrior River at Tuscaloosa, Ala.:

1901.

Feb. 1—Hydrographer, K. T. Thomas; gage height, 15.10; discharge, 9,300 second-feet.

March 15—Hydrographer, K. T. Thomas; gage height, 18.72; discharge, 9,461 second-feet.

June 27—Hydrographer, K. T. Thomas; gage height, 1.77; discharge, 828 second-feet.

Daily gage height of Black Warrior River at Tuscaloosa, Ala., for 1901.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec
1	19.50	15.10	7.50	28.00	9.40	6.50	1.70	0.70	6.11	5.40	0.85	1.60
2	19.00	14.80	7.30	26.50	8.50	12.25	1.73	0.60	5.10	6.91	0.80	1.60
3	17.90	15.00	8.40	32.60	7.90	16.65	2.00	0.85	4.05	9.00	0.75	1.40
4	14.70	35.20	9.65	35.10	7.30	14.80	2.25	1.00	3.60	6.72	1.00	1.40
5	13.00	42.00	9.70	31.50	7.00	12.00	2.50	0.80	3.05	5.30	1.10	1.31
6	11.50	38.25	9.50	27.50	6.35	11.20	2.30	0.75	2.81	4.50	1.10	1.95
7	10.25	32.15	9.00	24.30	6.15	11.10	2.50	0.60	2.35	3.45	1.05	1.90
8	9.50	29.15	8.50	20.90	6.00	11.50	2.40	0.50	2.04	3.02	1.00	2.58
9	8.75	28.05	8.05	17.90	5.70	9.40	2.25	0.35	1.90	2.50	0.95	2.60
10	8.30	30.97	8.70	14.50	5.60	7.60	2.10	0.25	1.70	2.31	0.90	3.80
11	17.40	29.75	29.50	12.50	5.00	6.50	2.00	0.20	1.50	2.10	0.90	5.00
12	52.70	27.45	34.00	11.00	4.60	6.25	1.70	0.65	1.41	1.95	0.85	5.80
13	56.50	25.15	28.50	10.00	5.00	6.40	1.30	0.65	1.30	3.41	1.00	5.70
14	53.25	22.50	23.50	11.35	6.60	5.50	0.90	0.80	2.52	3.30	1.05	7.40
15	47.25	19.60	19.70	12.80	8.70	5.05	0.70	1.20	6.70	3.97	1.00	31.00
16	41.45	17.45	16.00	13.00	8.30	4.80	0.60	5.70	8.00	3.80	0.98	40.75
17	36.30	15.70	13.00	11.70	6.80	4.50	0.43	17.00	6.10	3.51	0.90	35.00
18	31.85	13.70	11.05	12.80	5.50	4.10	2.60	26.30	12.21	3.00	0.93	27.00
19	28.15	12.50	10.00	25.70	4.70	3.80	4.00	22.70	16.00	2.70	1.10	21.50
20	25.15	11.90	9.60	39.80	4.90	3.75	5.70	25.70	14.50	2.30	1.30	16.41
21	22.50	10.90	13.00	42.60	8.30	3.00	7.33	32.10	10.60	2.00	1.40	12.10
22	19.85	9.95	16.50	38.00	17.30	2.75	6.00	32.50	7.50	1.81	1.70	9.95
23	17.55	9.20	15.70	32.80	19.80	2.30	4.50	31.97	5.70	1.61	2.00	7.00
24	15.35	8.75	14.00	28.41	17.50	2.20	3.20	26.80	4.51	1.45	2.05	6.80
25	14.60	8.65	13.80	24.40	14.10	2.00	2.50	22.40	3.90	1.31	2.00	7.30
26	18.00	8.50	28.50	21.00	11.30	1.97	2.00	18.30	3.40	1.20	1.95	8.34
27	17.20	8.20	37.25	17.90	9.30	1.85	1.50	14.10	2.91	1.05	1.95	9.00
28	15.50	7.90	34.50	14.90	8.15	1.70	1.05	9.85	2.60	0.81	2.00	10.96
29	14.80	......	29.00	12.50	7.00	1.65	0.90	7.90	2.91	0.55	1.95	16.30
30	15.10	......	24.30	10.90	6.90	1.65	0.80	7.41	4.80	0.90	1.91	49.00
31	14.60	......	24.85	......	6.35	......	0.60	7.10	......	0.90	......	49.00

Rating table for Black Warrior River at Tuscaloosa, Ala.

[This table is applicable from Jan. 1, 1895, to Dec. 31, 1901.]

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second ft.*	*Feet.*	*Second ft.*	*Feet.*	*Second ft.*	*Feet.*	*Second ft.*
—1.0	90	6.0	3,110	13.0	6,995	20.0	10,880
—0.9	105	6.1	3,160	13.1	7,045	20.1	10,950
—0.8	120	6.2	3,210	13.2	7,095	20.2	11,020
—0.7	140	6.3	3,260	13.3	7,145	20.3	11,090
—0.6	160	6.4	3,310	13.4	7,195	20.4	11,160
—0.5	180	6.5	3,370	13.5	7,255	20.5	11,230
—0.4	200	6.6	3,430	13.6	7,315	20.6	11,305
—0.3	220	6.7	3,490	13.7	7,375	20.7	11,380
—0.2	240	6.8	3,550	13.8	7,435	20.8	11,455
—0.1	260	6.9	3,610	13.9	7,495	20.9	11,530
0.0	280	7.0	3,665	14.0	7,550	21.0	11,600
0.1	310	7.1	3,715	14.1	7,600	21.1	11,690
0.2	340	7.2	3,765	14.2	7,650	21.2	11,780
0.3	370	7.3	3,815	14.3	7,700	21.3	11,870
0.4	400	7.4	3,865	14.4	7,750	21.4	11,960
0.5	430	7.5	3,925	14.5	7,810	21.5	12,050
0.6	460	7.6	3,985	14.6	7,870	21.6	12,140
0.7	490	7.7	4,045	14.7	7,930	21.7	12,230
0.8	530	7.8	4,105	14.8	7,990	21.8	12,320
0.9	565	7.9	4,165	14.9	8,050	21.9	12,410
1.0	600	8.0	4,220	15.0	8,105	22.0	12,500
1.1	635	8.1	4,270	15.1	8,155	22.1	12,600
1.2	670	8.2	4,320	15.2	8,205	22.2	12,700
1.3	710	8.3	4,370	15.3	8,255	22.3	12,800
1.4	750	8.4	4,420	15.4	8,305	22.4	12,900
1.5	790	8.5	4,480	15.5	8,365	22.5	13,000
1.6	830	8.6	4,540	15.6	8,425	22.6	13,100
1.7	870	8.7	4,600	15.7	8,485	22.7	13,200
1.8	910	8.8	4,660	15.8	8,545	22.8	13,300
1.9	955	8.9	4,720	15.9	8,605	22.9	13,400
2.0	1,000	9.0	4,775	16.0	8,660	23.0	13,500
2.1	1,045	9.1	4,825	16.1	8,710	23.1	13,620
2.2	1,090	9.2	4,875	16.2	8,760	23.2	13,740
2.3	1,135	9.3	4,925	16.3	8,810	23.3	13,860
2.4	1,180	9.4	4,975	16.4	8,860	23.4	13,980
2.5	1,225	9.5	5,035	16.5	8,920	23.5	14,100
2.6	1,270	9.6	5,095	16.6	8,980	23.6	14,220
2.7	1,320	9.7	5,155	16.7	9,040	23.7	14,340
2.8	1,370	9.8	5,215	16.8	9,100	23.8	14,460
2.9	1,420	9.9	5,275	16.9	9,160	23.9	14,580
3.0	1,470	10.0	5,330	17.0	9,215	24.0	14,700
3.1	1,520	10.1	5,380	17.1	9,265	24.1	14,830
3.2	1,570	10.2	5,430	17.2	9,315	24.2	14,960
3.3	1,620	10.3	5,480	17.3	9,365	24.3	15,090
3.4	1,670	10.4	5,530	17.4	9,415	24.4	15,200

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second ft.*	*Feet.*	*Second ft.*	*Feet.*	*Second ft.*	*Feet.*	*Second ft.*
3.5	1,725	10.5	5,590	17.5	9,475	24.5	15,350
3.6	1,780	10.6	5,650	17.6	9,535	24.6	15,480
3.7	1,835	10.7	5,710	17.7	9,595	24.7	15,610
3.8	1,890	10.8	5,770	17.8	9,655	24.8	15,740
3.9	1,945	10.9	5,830	17.9	9,715	24.9	15,870
4.0	2,000	11.0	5,885	18.0	9,770	25.0	16,000
4.1	2,055	11.1	5,935	18.1	9,820	26.0	17,600
4.2	2,111	11.2	5,985	18.2	9,870	28.0	21,500
4.3	2,166	11.3	6,035	18.3	9,920	30.0	26,500
4.4	2,222	11.4	6,085	18.4	9,970	32.0	31,700
4.5	2,277	11.5	6,145	18.5	10,030	34.0	38,000
4.6	2,333	11.6	6,205	18.6	10,090	36.0	45,000
4.7	2,388	11.7	6,265	18.7	10,150	38.0	53,000
4.8	2,444	11.8	6,325	18.8	10,210	40.0	61,000
4.9	2,500	11.9	6,385	18.9	10,270	42.0	69,000
5.0	2,555	12.0	6,440	19.0	10,325	44.0	77 000
5.1	2,610	12.1	6,490	19.1	10,375	46.0	85,000
5.2	2,666	12.2	6,540	19.2	10,425	48.0	93,000
5.3	2,721	12.3	6,590	19.3	10,475	50.0	101,000
5.4	2,777	12.4	6,640	19.4	10,525	52.0	109,000
5.5	2,832	12.5	6,700	19.5	10,585	54.0	117,000
5.6	2,888	12.6	6,760	19.6	10,645	55.0	121,000
5.7	2,943	12.7	6,820	19.7	10,705		
5.8	3,000	12.8	6,880	19.8	10,765		
5.9	3,054	12.9	6,940	19.9	10,825		

NOTE.—This table applied to the foregoing "Daily gage heights" gives the cubic feet per second flowing in the river on each date for which the gage height is given.

Estimated monthly discharge of Black Warrior River at Tuscaloosa, Alabama.

[Drainage area, 4,900 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean		Depth in inches.	Second-ft. per sq. mile.
1895.						
January	103,400	2,777	25,464	1,565,720	6.00	5.20
February	14,830	4,775	7,603	422,249	1.61	1.55
March	109,000	4,540	39,977	2,458,106	9.42	8.16
April	14,700	3,665	6,895	410,280	1.57	1.41
May	13,860	2,000	5,511	338,860	1.29	1.12
June	3,665	1,000	2,133	126,922	0.49	0.44
July	9,970	1,000	3,581	220,189	0.84	0.73
August	2,500	565	1,098	67,514	0.25	0.22
September	1,835	310	883	52,542	0.20	0.18
October	310	140	233	14,327	0.06	0.05
November	750	280	488	29,038	0.11	0.10
December	11,600	530	2,021	124,267	0.47	0.41
1896.						
January	24,610	2,444	5,981	367,757	1.41	1.22
February	47,000	3,665	19,161	1,102,153	4.22	3.91
March	52,600	3,160	12,996	799,093	3.06	2.65
April	14,100	2,721	6,072	361,309	1.38	1.24
May	49,800	1,370	7,420	456,238	1.74	1.51
June	9,970	1,090	2,910	173,157	0.65	0.59
July	4,420	460	1,232	75,753	0.29	0.25
August	750	310	478	29,391	0.12	0.10
September	400	120	201	11,960	0.04	0.04
October	260	120	157	9,654	0.03	0.03
November	600	120	307	18,268	0.07	0.06
December	4,045	430	955	58,721	0.22	0.19
1897.						
January	10,500	385	3,493	214,775	0.82	0.71
February	17,440	1,945	8,409	467,010	1.79	1.72
March	120,080	4,540	52,883	3,251,650	12.44	10.79
April	25,285	2,610	9,657	574,630	2.20	1.97
May	11,195	1,000	3,600	221,355	0.84	0.73
June	1,697	260	715	42,545	0.17	0.15
July	7,810	240	1,809	111,230	0.43	0.37
August	1,595	355	701	43,100	0.16	0.14
September	600	102	295	17,555	0.07	0.06
October	102	90	93	5,718	0.02	0 02
November	125	107	115	6,843	0.03	0.02
December	29,000	115	5,549	341,195	1.30	1.13
1898.						
January	75,000	1,972	16,577	1,019,287	3.90	3.38
February	12,230	1,752	3,902	216,706	0.83	0.80

Estimated monthly discharge of Black Warrior River at Tuscaloosa, Alabama.

[Drainage area, 4,900 square miles.]

Month.	Discharge in second-feet.			Total in acre-ft.	Run-off.	
	Maxi-mum.	Mini-mum.	Mean.		Depth in inches.	Second-ft. per sq. mile.
March	17,120	1,370	3,626	222,955	0.85	0.74
April	55,800	4,295	15,620	929,452	3.56	3.19
May	6,060	370	1,766	108,589	0.41	0.36
June	710	160	303	18,030	0.07	0.06
July	1,395	250	549	33,757	0.13	0.11
August	7,600	430	1,785	109,756	0.41	0.36
September	670	140	252	14,995	0.06	0.05
October	2,444	130	880	54,109	0.21	0.18
November	6,265	280	1,626	96,754	0.37	0.33
December	14,580	1,045	3,763	231,379	0.89	0.77
1899.						
January	81,375	2,222	18,118	1,114,033	4.27	3.70
February	90,375	10,030	30,923	1,717,376	6.57	6.31
March	122,625	5,330	35,308	2,171,004	8.31	7.21
April	32,800	4,540	11,901	708,158	2.71	2.43
May	4,165	790	2,092	128,632	0.49	0.43
June	1,000	175	448	26,658	0.10	0.09
July	5,035	160	1,111	68,313	0.26	0.23
August	3,370	370	963	59,213	0.23	0.20
September	670	110	200	11,901	0.04	0.04
October	175	92	130	7,993	0.03	0.03
November	5,590	127	721	42,902	0.17	0.15
December	47,650	460	8,880	546,010	2.09	1.81
1900.						
January	29,760	2,277	9,857	606,083	2.01	2.32
February	76,312	2,555	18,356	1,019,440	3.75	3.90
March	87,750	8,280	27,105	1,666,623	5.53	6.37
April	136,687	5,302	48,426	2,881,547	9.88	11.02
May	11,825	1,645	3,702	227,627	0.76	0.88
June	115,312	2,138	32,614	1,940,668	6.66	7.43
July	52,000	2,888	10,952	673,412	2.24	2.59
August	5,245	750	1,674	102,930	0.34	0.39
September	5,680	512	1,580	94,017	0.32	0.36
October	13,000	355	3,382	207,951	0.69	0.80
November	12,700	977	3,701	220,225	0.76	0.85
December	10,150	2,721	5,119	314,755	1.05	1.21
The year	136,687	355	13,872	9,955,278	2.83	38.12

Estimated monthly discharge of Black Warrior River at Tuscaloosa, Alabama.

[Drainage area, 4,900 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1901.					
January	108,375	4,370	22,938	4.68	5.39
February	55,100	4,165	15,094	3.08	3.21
March	40,900	3,815	11,947	2.44	2.81
April	57,020	5,380	17,370	3.55	3.96
May	10,765	2,338	4,355	.89	1.03
June	9,010	850	3,217	.66	.74
July	3,815	415	1,210	.25	.29
August	29,550	340	7,117	1.45	1.67
September	8,660	710	2,626	.54	.60
October	4,775	445	1,536	.31	.36
November	1,022	512	712	.15	.17
December	80,250	710	13,293	2.71	3.12
The year	108,375	340	8,454	1.73	23.35

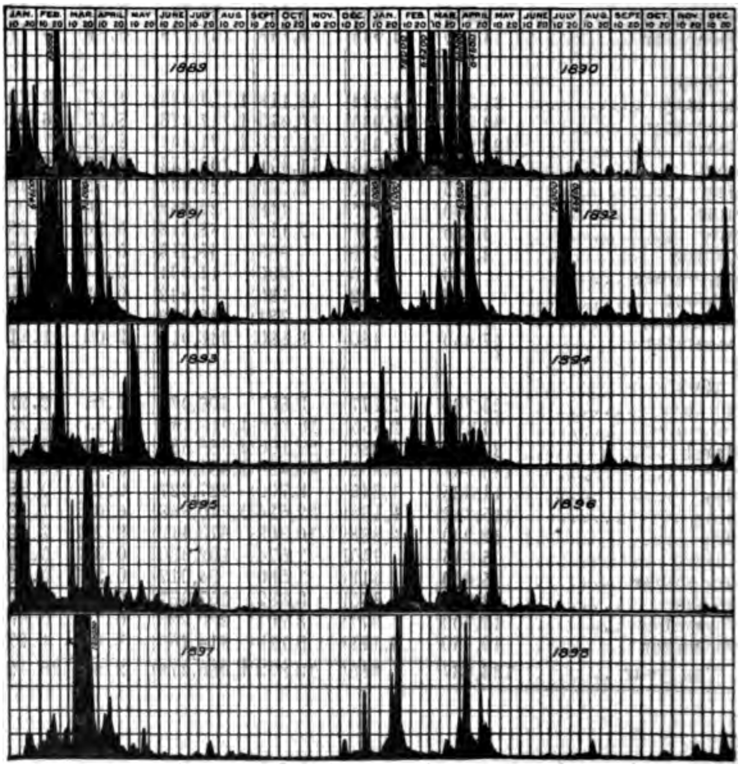

FIG. 14.—Discharge of Black Warrior River at Tuscaloosa, Alabama, 1889-1898.

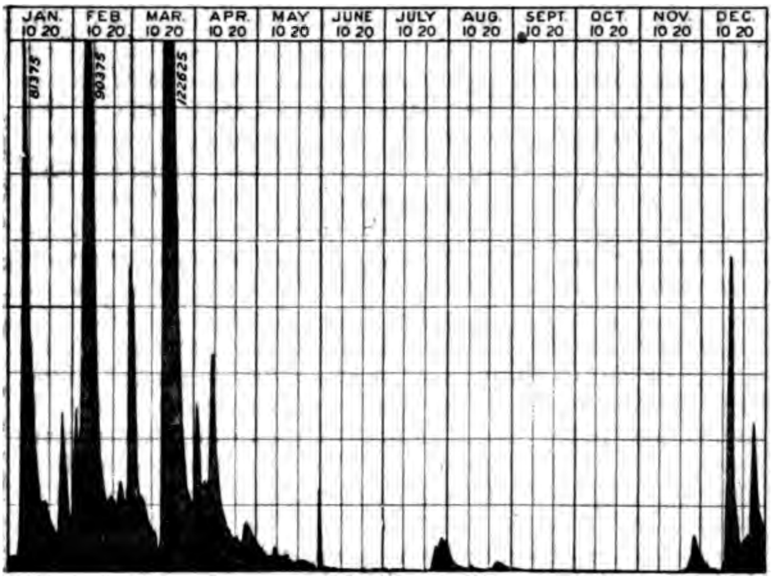

FIG. 15.—Discharge of Black Warrior River at Tuscaloosa, Alabama, 1899.

Minimum monthly discharge of Black Warrior River at Tuscaloosa, Ala., with corresponding net horse power per foot of fall on a water wheel realizing 80 per cent. of the theoretical power.

[Drainage area, 4,900 square miles.]

	1899			1900			1901		
	Minimum cubic feet per second.	Minimum net H. P. per foot of fall.	No. of days duration of minimum.	Minimum cubic feet per second.	Minimum net H. P. per foot of fall.	No. of days duration of minimum.	Minimum cubic feet per second.	Minimum net H. P. per foot of fall.	No. of days duration of minimum.
January	2,222	202	1	2,277	207	1	4,370	398	1
February	10,030	912	2	2,555	232	1	4,165	378	1
March	5,330	485	1	8,282	753	1	3,815	347	1
April	4,539	413	1	5,302	483	1	5,330	485	1
May	790	72	1	1,645	150	1	2,333	212	1
June	175	16	1	2,138	194	1	850	77	2
July	160	15	7	2,888	262	1	415	38	1
August	370	34	2	750	68	2	340	31	1
September ...	110	10	1	512	47	1	710	65	1
October	92	9	1	355	32	1	445	40	1
November	127	12	5	977	89	1	512	47	1
December	460	42	1	2,721	247	1	710	65	1

2. BLACK WARRIOR RIVER NEAR CORDOVA, ALABAMA.

This station is located at the Kansas City, Memphis & Birmingham Railroad bridge, three-fourths of a mile from Cordova, Alabama. The gage was established by the United States Weather Bureau, but the records were discontinued by that bureau some time ago. From 12 to 55 feet the gage is a vertical timber bolted to the inside of the bridge pier on the left bank of the river. Below 12 feet the gage was sloping, but it was out of position, and could not be used when the station was established by the Geological Survey on May 21, 1900, so a short new section was put in at that time. This section is a 2-inch by 10-inch plank, graduated to feet and tenths, marked with nails from —1.5 feet to +12.5 feet, and spiked to a willow tree on the right bank of the river about 200 feet below the bridge. The bench mark is the top of the stone pier on the left bank, and is 54.95 feet above the zero of the gage. Measurements are made from the railroad bridge, which is a single-span, iron, through bridge 300 feet long. The section is a good one. The observer is A. B. Logan, who lives on the right bank of the river, only a few hundred feet from the end of the bridge. During 1900 measurement was made by Max Hall as follows:

Daily gage height, in feet, of Black Warrior River near Cordova, Alabama, for 1900.

Day	May.	June	July	Aug.	Sept.	Oct.	Nov.	Dec
1	......	0.6	8.1	0.9	0.5	—0.8	—0.1	1.4
2	......	2.8	5.2	.5	.2	— .8	+ .5	1.0
3	......	5.3	7.1	.4	.1	— .9	.8	.8
4	......	7.1	6.5	.2	.0	— .9	.4	1.0
5	......	7.5	5.3	.1	— .1	—1.0	.3	1.9
6	......	7.6	4.6	.0	— .2	—1.0	.3	1.8
7	......	6.5	3.5	.1	— .3	—1.1	.2	1.4
8	......	7.3	2.1	.2	— .4	+ .2	.2	1.2
9	......	6.5	2.5	.3	— .5	.9	.1	1.0
10	......	4.5	2.7	.3	— .5	.9	.0	.8
11	......	3.2	1.0	.4	— .6	.1	— .1	.7
12	......	3.0	.8	.5	— .6	9.4	— .2	.7
13	......	4.6	1.0	.5	— .7	9.2	— .2	.8
14	......	8.6	.8	.5	— .6	3.2	— .3	.8
15	......	9.8	.5	.6	1.5	2.3	— .3	.8
16	......	8.0	.4	.6	.9	1.7	— .3	.6
17	......	8.2	.4	.6	.5	1.0	— .4	.5
18	......	7.2	.3	.6	.1	.6	+ .3	.4
19	......	13.4	.3	.1	.0	.3	.2	.4
20	......	10.0	.2	.0	— .1	.2	.1	.5
21	0.1	6.1	.7	.2	— .2	.1	.3	1.5
22	.1	6.5	1.0	.3	— .3	.0	1.1	3.0
23	.1	15.2	.8	.4	— .3	1.0	.8	2.9
24	1.5	32.9	.5	.8	— .4	.7	.8	5.0
25	1.5	33.8	.9	1.7	— .4	.5	.9	4.0
26	1.0	31.3	.5	.8	— .5	.3	5.1	3.1
27	.6	22.1	1.6	.2	— .5	.2	4.9	2.5
28	.7	23.9	2.4	.0	— .6	.1	3.6	2.1
29	.8	22.4	1.3	.1	— .7	.0	2.8	1.8
30	.9	16.5	1.2	.9	— .7	— .1	1.9	1.7
31	.9	....	1.5	1.0	.....	— .1	.....	2.8

During 1901 the following discharge measurements were made on Black Warrior River at Cordova, Alabama:

1901.

Jan. 8—Hydrographer, Max Hall; gage height, 1.30; discharge, 1,781 second-feet.

Feb. 18—Hydrographer, K. T. Thomas; gage height, 2.40; discharge, 2,863 second-feet.

March 12—Hydrographer, K. T. Thomas; gage height, 9.45; discharge, 13,279 second-feet.

April 17—Hydrographer, K. T. Thomas; gage height, 1.70; discharge, 2,024 second-feet.

June 20—Hydrographer, K. T. Thomas; gage height, 0.00; discharge, 644 second-feet.

Oct. 26—Hydrographer, K. T. Thomas; gage height, —0.40; discharge, 385 second-feet.

Daily gage height, in feet, of Black Warrior River near Cordova, Alabama, for 1901.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec
1..........	3.7	4.00	1.00	5.40	1.7	1.6	+0.1	—0.6	0.7	1.2	—0.4	— 0.2
2..........	3.1	3.60	1.60	9.20	1.5	4.5	0.3	—0.6	0.5	0.8	—0.5	— 0.2
3..........	2.8	4.50	2.30	14.50	1.3	2.8	0.1	—0.65	0.4	0.5	—0.5	— 0.1
4..........	2.5	17.60	1.90	10.90	1.1	2.1	0.0	—0.65	0.2	0.4	—0.4	0.0
5..........	2.3	18.00	1.60	7.00	1.0	2.0	—0.2	—0.70	0.1	0.3	—0.4	0.1
6..........	2.0	9.10	1.80	5.80	0.8	2.6	—0.2	—0.70	0.0	0.2	—0.4	0.1
7..........	1.7	5.60	1.50	4.90	0.7	2.7	—0.3	—0.70	—0.1	0.1	—0.3	0.1
8..........	1.5	5.20	1.30	4.20	0.6	[illegible]	—0.3	—0.65	—0.2	0.0	—0.3	0.1
9..........	1.3	7.10	1.50	3.50	0.5	1.5	—0.4	—0.60	—0.3	—0.1	—0.4	0.1
10..........	2.6	8.10	17.50	2.80	0.4	1.1	—0.5	—0.60	—0.4	—0.2	—0.4	0.7
11..........	19.9	6.20	20.50	2.30	0.3	2.2	—0.6	—0.60	—0.5	—0.2	—0.4	1.2
12..........	32.5	5.40	10.80	2.10	0.4	1.5	—0.6	—0.30	—0.3	—0.2	—0.3	1.0
13..........	29.85	4.80	6.20	1.80	0.6	1.1	—0.6	+ .40	—0.3	0.0	—0.3	0.8
14..........	17.85	4.20	5.30	2.50	3.1	1.0	—0.7	.10	+0.5	+1.1	—0.3	6.2
15..........	9.25	3.80	4.20	2.80	1.8	0.9	—0.7	.20	0.7	0.6	—0.3	2 4
16..........	6.80	3.30	3.50	2.30	1.3	0.7	—0.7	5.00	0.5	0.3	—0.4	1.52
17..........	5.50	2.90	2.80	1.80	0.9	0.6	—0.6	12.10	3.8	0.1	—0.4	8.1
18..........	4.30	2.60	2.20	2.20	0.7	0.5	0.0	6.80	5.0	0.0	—0.4	5.3
19..........	3.80	2.20	1.90	9.40	0.9	0.3	+1.1	10.80	3.5	—0.1	—0.2	3.5
20..........	3.10	2.00	2.40	16.10	1.8	0.2	2.8	8.70	1.8	—0.2	0.0	2.6
21..........	2.80	1.80	5.00	11.50	5.8	0.0	1.6	8.50	1.1	—0.2	—0.1	2 0
22..........	2.60	1.60	4.20	6.80	7.3	—0.1	0.5	11.20	0.8	—0.3	—0.1	1.5
23..........	2.40	1.30	3.50	5.40	5.5	—0.2	0.0	7.30	0.5	—0.3	0.0	1.5
24..........	2.60	1.40	3.50	4.50	3.6	—0.3	—0.2	5.20	0.4	—0.4	—0.1	2.0
25..........	5.40	1.20	4.95	3.60	2.8	—0.3	—0.3	4.00	0.3	—0.4	—0.2	2 5
26..........	5.00	1.20	11.20	3.00	2.1	—0.3	—0.4	2.80	0.2	—0.4	—0.2	2.1
27..........	3.80	1.10	6.90	2.60	1.6	—0 4	—0.5	2.00	0.1	—0.4	—0.1	2.6
28..........	4.20	1.00	5.30	2.20	1.3	—0.4	—0.5	1.50	0.1	—0.4	—0.1	5.0
29..........	3.80	......	4.60	2.00	1.1	—0.4	—0.5	1.40	1.0	—0.5	—0.2	18 5
30..........	3.60	......	4.00	1.90	1.0	—0.5	—0.3	1.20	2.3	—0.5	—0.2	22.0
31..........	4.20	......	6.20	......	1.0	.....	—0.6	1.00	......	—0.5	.....	13.5

Rating table for Black Warrior River at Cordova, Alabama, for 1900 and 1901.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second ft.*	*Feet.*	*Sec. ft.*	*Feet.*	*Second ft.*	*Feet*	*Second ft.*
—0.7	205	3.3	4,144	7.3	10,064	11.3	15,984
—0.6	260	3.4	4,292	7.4	10,212	11.4	16,132
—0.5	320	3.5	4,440	7.5	10,360	11.5	16,280
—0.4	384	3.6	4,588	7.6	10,508	11.6	16,428
—0.3	450	3.7	4,736	7.7	10,656	11.7	16,576
—0.2	518	3.8	4,884	7.8	10,804	11.8	16,724
—0.1	588	3.9	5,032	7.9	10,952	11.9	16,872
0.0	660	4.0	5,180	8.0	11,100	12.0	17,020
0.1	734	4.1	5,328	8.1	11,248	12.1	17,168
0.2	810	4.2	5,476	8.2	11,396	12.2	17,316
0.3	888	4.3	5,624	8.3	11,544	12.3	17,464
0.4	968	4.4	5,772	8.4	11,692	12.4	17,612
0.5	1,050	4.5	5,920	8.5	11,840	12.5	17,760
0.6	1,134	4.6	6,068	8.6	11,988	12.6	17,908
0.7	1,220	4.7	6,216	8.7	12,136	12.7	18,056
0.8	1,307	4.8	6,364	8.8	12,284	12.8	18,204
0.9	1,396	4.9	6,512	8.9	12,432	12.9	18,352
1.0	1,486	5.0	6,660	9.0	12,580	13.0	18,500
1.1	1,577	5.1	6,808	9.1	12,728	13.1	18,648
1.2	1,669	5.2	6,956	9.2	12,876	13.2	18,796
1.3	1,762	5.3	7,104	9.3	13,024	13.3	18,944
1.4	1,856	5.4	7,252	9.4	13,172	13.4	19,092
1.5	1,951	5.5	7,400	9.5	13,320	13.5	19,240
1.6	2,047	5.6	7,548	9.6	13,468	13.6	19,388
1.7	2,144	5.7	7,696	9.7	13,616	13.7	19,536
1.8	2,242	5.8	7,844	9.8	13,764	13.8	19,684
1.9	2,342	5.9	7,992	9.9	13,912	13.9	19,832
2.0	2,444	6.0	8,140	10.0	14,060	14.0	19,980
2.1	2,547	6.1	8,288	10.1	14,208	14.1	20,128
2.2	2,652	6.2	8,436	10.2	14,356	14.2	20,276
2.3	2,758	6.3	8,584	10.3	14,504	14.3	20,424
2.4	2,868	6.4	8,732	10.4	14,652	14.4	20,572
2.5	2,988	6.5	8,880	10.5	14,800	14.5	20,720
2.6	3,118	6.6	9,028	10.6	14,948	14.6	20 868
2.7	3,258	6.7	9,176	10.7	15,096	14.7	21,016
2.8	3,404	6.8	9,324	10.8	15,244	14.8	21,164
2.9	3,552	6.9	9,472	10.9	15,392	14.9	21,312
3.0	3,700	7.0	9,620	11.0	15,540	15.0	21,460
3.1	3,848	7.1	9,768	11.1	15,688		
3.2	3,996	7.2	9,916	11.2	15,836		

NOTE.—This table applied to the foregoing "Daily gage heights" gives the cubic feet per second flowing in the river on each date for which the gage height is given.

Estimated monthly discharge of Mulberry Fork of Black Warrior River, near Cordova, Alabama.

[Drainage area, 237 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1900.					
June	49,284	1,134	16,185	8.52	9.51
July	11,248	810	2,975	1.57	1.81
August	2,144	660	1,016	.53	.61
September	1,951	205	556	.29	.32
October	13,098	60	1,732	.91	1.05
November	6,808	384	1,487	.78	.87
December	6,660	968	2,154	1.13	1.30
1901.					
January	51,800	1,762	8,713	4.59	5.29
February	31,820	1,486	6,616	3.48	3.62
March	29,600	1,486	6,637	3.49	4.02
April	23,088	2,242	6,967	3.67	4.10
May	10,064	968	2,539	1.34	1.54
June	5,920	320	1,582	.83	.93
July	3,404	205	631	.33	.38
August	17,168	205	4,155	2.19	2.53
September	6,660	320	1,415	.74	.83
October	1,669	320	687	.36	.42
November	660	320	468	.25	.28
December	31,820	518	4,923	2.59	2.99
The year	51,800	205	3,778	1.99	26.93

Minimum monthly discharge of Black Warrior River at Cordova, Ala., with corresponding net horse power per foot of fall on a water wheel realizing* 80 *per cent. of the theoretical power.

[Drainage area. 237 square miles.]

	1900			1901		
	Minimum cubic feet per second.	Minimum net H. P. per foot of fall.	No. of days duration of minimum.	Minimum cubic feet per second.	Minimum net H. P. per foot of fall.	No. of days duration of minimum.
January	......	......	....	1,762	160	1
February	......	......	....	1,486	135	1
March	......	......	....	1,486	135	1
April	......	......	....	2,242	204	2
May	734	67	3	968	88	1
June	1,134	103	1	320	29	1
July	810	74	1	205	19	3
August	660	60	3	205	19	3
September	205	19	3	320	29	1
October	60	55	1	320	29	3
November	384	35	1	320	29	2
December	968	88	2	518	47	2

NOTE.—To find the minimum net horse power available at a shoal on this stream, near this station, for any month, multiply the total fall of the shoal by the "Net H. P, per foot of fall" in this table for that month.

3. SURVEY OF BLACK WARRIOR RIVER, ALABAMA.

The Black Warrior River is formed by the junction of the Mulberry and Sipsey forks of Black Warrior at Old Warrior Town in Walker County, Alabama, and runs in a southwesterly direction past Tuscaloosa to Demopolis, Ala., at which point it enters the Tombigbee River. Above Tuscaloosa it is known as the Black Warrior River, and below Tuscaloosa as the Warrior River.

The accompanying profile is made from the surveys of the Corps of Engineers, U. S. A.

A great deal of work is being done by the Government on this river in order to make it navigable as an outlet to important coal fields above.

In the 92 miles from Old Warrior Town to Tuscaloosa, there is a fall of 158 feet. The distribution of this fall is shown by the following table, giving distances in miles above Tuscaloosa and elevations of water surface above sea level.

Miles above Tuscaloosa.	Elevation above sea level.	
92.4	249.7	Fork of Sipsey and Mulberry.
85.3	248.8	Black Water Creek.
84.6	242.3	Foot of Sanders Shoals.
79.7	242.1	Big Cane Creek.
76.2	240.8	Above Paynes Mill.
76.2	237.1	Below Paynes Mill.
74.4	231.7	Foot of Bee Shoals.
71.2	231.6	Birch Shoals.
71.2	230.6	Birch Shoals.
69.0	230.0	Top of Tuggles Shoals.
68.0	225.6	Foot of Tuggles Shoals.
55.0	216.6	Mouth of Lost Creek.
48.0	215.1	Mouth of Little Warrior River.
47.6	206.1	Foot of Fork Shoals.
43.3	296.1	Above Knight's Mill.
43.3	202.5	Below Knight's Mill.
38.0	202.2	Above Black Rock.
37.7	193.0	Below Black Rock.
30.3	192.3	Top of Squaw Shoals.
25.8	151.3	Foot of Squaw Shoals.
21.7	139.8	Foot of Fair Shoals.
19.3	132.3	Foot of Rose Shoals.
8.7	132.30	Top of Lock 4, at Lower Yellow Creek.
2.0	120.16	Top of Lock 3, Tuscaloosa, Ala.
1.3	109.66	Top of Lock 2, Tuscaloosa, Ala.
0.7	101.16	Top of Lock 1, Tuscaloosa, Ala.
	91.30	Foot of Lock 1, Tuscaloosa, Ala.

There are gage stations, both at Tuscaloosa and Cordova, Ala., where systematic discharge measurements have been made, the results of which are given in the foregoing pages. Comparative measurements at the two stations at same stage, which was same stage as low water in November, 1901, shows a discharge of 825 second-feet at Tuscaloosa, and 285 second-feet at Cordova. At minimum stage of dryest years the water gets considerably lower, as is shown by the records referred to, but the figures named are safe for low season in all ordinary years, and will be used in this discussion, for determining the power available at different sites along the river.

The locks and proposed locks on this section of the river begin with No. 1, at Tuscaloosa, and are numbered up the river. Locks 1, 2, 3 and 4 are about completed, and others are projected, but the locations of the latter in the following list are approximated. However, the exact location of each is immaterial in showing the power available. The following is a table showing positions of locks and lock sites in miles above Tuscaloosa, the sea level elevation of water below each, the lift at each and the net horsepower that can be developed at each day on an 80 per cent. turbine during dry season in ordinary years, like 1900, after deducting 100 second-feet for lockage.

No. of lock or site.	Miles from Tuscaloosa.	Sea-level elevation of water below lock.	Lift.	Sec.-ft. after deducting 100 for lockage.	Net H. P. on 80 per cent. turbine without storage.	Location.
1	0.7	91.30	9.86	725	650	Bottom University Shoal, Tuscaloosa.
2	1.3	101.16	8.50	725	560	On University Shoal, Tuscaloosa.
3	2.0	109.66	10.50	725	690	On University Shoal, Tuscaloosa.
4	8.7	120.16	12.14	704	777	Near mouth of Yellow Creek.
5	19.3	132.30	10.00	660	600	Foot of Rose Shoals.
6	21.7	142.30	9.00	660	540	Foot of Fair Shoals.
7	25.8	151.30	14.00	660	840	Foot of Squaw Shoals.
8	26.3	165.30	14.00	660	840	On Squaw Shoals.
9	27.8	179.30	14.00	660	840	On Squaw Shoals.
10	37.7	193.3	14.00	550	700	Below Black Rock.
11	47.6	207.3	14.00	550	700	Mouth of Little Warrior River, or Locust Fork.
12	63.4	221.3	14.00	374	476	
13	75.0	235.3	14.00	285	364	

The best power on the river is at Squaw Shoals, 26 miles above Tuscaloosa, covered on the above table by locks Nos. 7, 8 and 9, each having a lift of 14 feet, and making a total fall on Squaw Shoals of 42 feet. This can be developed to best advantage by constructing a canal from the top of proposed dam at Lock No. 9, along the river bank, two miles in length, to a point opposite the foot of Squaw Shoals, below Lock No. 7. This canal taking the river water not need for lockage, and allowing two feet for grade and storage, will utilize a net head of 40 feet, and produce 2,400 net horse power continuously, or 4,800 net horse power for a 12-hour run per day, storing the water above Lock No. 9 during the 12 idle hours.

It is to be remembered that the above estimates of power are for low season during ordinary years. There will be exceptional periods of minimum water in extremely dry years in which the entire flow of the river will be as low as 100 second-feet, and will, therefore, barely suffice for lockage during a busy season of boating on the river. See Nineteenth Annual Report, United States Geological Survey, Part IV, page 251. But such seasons are rare, and the facilities for water transportation should compensate for them to a great extent. It is admitted that the cheapness of coal along this river would naturally make the water powers less valuable, but the cheapness of development in connection with Government dams would partly offset the cheapness of coal. It is believed that the proposed development at Squaw Shoals could be made at a very moderate cost, and that such an investment would pay handsomely.

APPENDIX TO BLACK WARRIOR REPORT.

The following additional information concerning the Warrior and Black Warrior River is from Mr. R. C. McCalla, U. S. Assistant Engineer, Tuscaloosa, Ala., who is in charge of the improvements on that river.

Tuscaloosa is 361 miles by river above Mobile, and above here the river is called the Black Warrior, and below it is called the Warior. The locks on the two parts of the stream are numbered as two separate systems, the lowest lock in each system being No. 1, and the numbers running up stream. The following table gives the lift and location of the locks in both systems:

No. of lock.	Lift in feet.	Miles above Mobile.	
1	10.00	230.5	..............0.5 miles below mouth of Warrior; located but not begun.
2	10.00	246.2	..............Located but not begun.
3	10.00	266.7	..............Located but not begun.
4	10.00	282.3	..............Under construction.
5	10.00	298.3	..............Under construction.
6	10.00	315.2	..............Under construction.
1	9.86	361.9	..............In operation.
2	8.50	362.3	..............In operation.
3	10.50	363.1	..............In operation.
4	12.14	370.1	..............Under construction.

Between Lock No. 4 and the junction of Mulberry and Locust Forks, 407.8 miles above Mobile, there are projected seven locks at 14 feet lift each, but none of these are yet located. The following table gives the location, etc., of gages now established and read daily at 7 A. M.:

Name of Gauge.	No. of gauges.	Miles above Mobile.	Elevation of zero above mean low tide, Mobile.	Remarks.
Demopolis	1	229.7	28.07	Zero. about 1¼ ft. above mean low water.
Millwood	1	259.8	45.97	Zero about mean low water.
Lock 4.........	1	282.3	54.50	Zero top of lower mitre sill.
A. G. S. bdge	1	288.0	61.26	Zero about mean low water.
Lock 5.........	1	298.3	64.50	Zero top of lower mitre sill.
Lock 6.........	1	315.2	74.50	Zero top of lower mitre sill.
Grays Landg.	1	319.5	80.41	Zero about mean low water.
Tuscaloosa ...	1	361.1	86.86	Zero about 1 ft. above mean low water.
Lock 1.........	2	361.9	84.36	Zero top of lower mitre sill.
Lock 2.........	2	362.3	94.36	Zero top of lower mitre sill.
Lock 3.........	2	363.1	102.86	Zero top of lower mitre sill.
Lock 4.........	1	370.1	113.36	Zero top of lower mitre sill.
Cordova	1	445.0	237.35	Zero about mean low water.

5. BLACK WARRIOR RIVER TRIBUTARIES.

At Clear Creek Falls, in Winston County, within a distance of half a mile, there is a fall of over 100 feet, distributed as follows:

Rapids above Upper Falls in 100 yards	6 feet fall
Upper Falls, about	45 feet fall
Still pool for 275 yards	00 feet fall
Lower Falls	27 feet fall
Rapids below Lower Falls	30 feet fall

No discharge measurements have ever been made on this stream. It is thought best not to attempt to approximate its flow by any water-shed rule, as the stream originates from big springs. Actual discharge measurements will be made during 1902.

Little Warrior, or Locust Fork, is an important stream on which no surveys have been made. On December 1, 1901, a hydrographic station was established on this stream at Palos, Ala., by Mr. R. C. McCalla, U. S. Assistant Engineer, and will be maintained by him.

Mr. B. M. Hall and his assistants will make a series of discharge measurements at this station during 1902. The only measurement so far was on January 18, 1902. The gage stood at 0.85, and the discharge was 849 second-feet.

There are other tributaries having shoals that can be developed, but they have not been examined.

CHAPTER VI.

1. TOMBIGBEE RIVER AT COLUMBUS, MISSISSIPPI.

This station is located about 1,000 feet below the highway bridge, 1½ miles from the Southern Railway depot at Columbus. The rod, which is in three sections, is fastened vertically to the rock bluff on the left bank. It is a 3-inch by 10-inch pine timber 45 feet long, marked with brass figures and copper nails, the graduation extending from —5.0 feet to +40.0 feet. The initial point of sounding is the end of the iron bridge, right bank, downstream side. Bench mark No. 1 is 250 feet from the initial point of sounding. The bridge floor is 40.85 feet above the zero of the rod, and the top of the iron girder under the floor timbers is 39.85 feet above the zero. Bench mark No. 2 is the top of the rail at the depot of the Southern Railway, and is 55.2 feet above gage datum and 190.9 feet above mean sea level. The width of the river at low water is 160 feet. The maximum record height of the river was on April 8, 1892, when the gage registered 42 feet. The lowest recorded height was on October 26, 1893, when the gage reading was —3.9 feet. The danger line is at 33 feet. No measurements of discharge were made during 1900.

Daily gage height in feet of Tombigbee River at Columbus, Miss., for 1900.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec
1	3.5	0.4	7.1	4.5	8.0	1.0	19.7	5.8	— 1.2	— 2.7	+ 2.6	+ 3.4
2	2.2	.3	6.8	3.8	6.5	8.0	18.3	4.0	— 1.0	— 2.8	+ 4.9	+ 2.5
3	1.8	.2	5.6	2.7	5.9	10.0	17.6	2.8	— 1.0	— 3.0	+ 5.5	+ 1.9
4	1.6	.4	4.4	1.9	4.5	13.4	16.2	1.9	— .7	— 3.1	+ 5.1	+ 1.0
5	1.4	1.8	3.8	1.5	2.8	15.3	15.9	1.0	— .6	— 3.3	+ 4.4	+ .1
6	1.2	3.5	3.4	1.3	1.5	17.0	15.4	.0	— .9	— 3.5	+ 3.1	+ .2
7	1.1	3.5	7.6	1.3	.8	20.7	14.5	— .5	— 1.3	— 3.5	+ 1.9	+ .3
8	1.0	3.3	11.4	1.1	.5	23.6	13.5	— .9	— 1.9	— 2.2	+ .9	+ .3
9	.9	4.2	15.1	.7	1.4	25.5	10.0	— 1.4	— 2.1	— 1.0	— .1	.0
10	.9	8.4	13.8	.5	2.3	25.0	6.8	— 1.8	— 2.3	— .6	— .5	— .3
11	2.0	7.8	11.3	11.7	3.3	23.6	5.5	— 2.2	— 2.4	— .4	— .9	+ .5
12	6.6	7.6	9.9	16.2	3.6	21.6	4.0	— 2.6	— 2.5	+ 2.6	— 1.1	— .6
13	8.3	10.2	6.7	17.4	2.8	20.0	3.5	— 2.6	— 2.6	+ 4.8	— 1.3	+ .9
14	7.1	9.8	4.3	19.3	2.2	18.5	2.0	— 2.7	— 2.7	+ 5.2	— 1.3	+ .9
15	5.6	8.1	4.8	20.8	1.6	17.8	1.9	— 2.2	— 2.7	+ 5.6	— 1.4	+ .9
16	4.6	5.8	5.6	20.5	+ .7	17.1	1.5	— 2.2	— 2.8	+ 5.4	— 1.5	+ .9
17	2.8	4.6	5.2	22.9	.0	17.3	1.0	— 2.3	— 2.9	+ 2.4	— 1.5	+ .9
18	2.4	3.8	4.6	26.9	— .4	17.8	.5	— 2.3	— 3.0	+ .4	— 1.6	— 1.0
19	2.2	3.2	9.4	27.6	— 1.0	18.0	.0	— 1.8	— 3.0	— .4	— 1.6	— 1.0
20	2.1	2.8	15.6	27.5	— .8	16.8	.4	— 1.4	— 3.1	— .9	— 1.6	— 1.0
21	1.9	3.5	18.2	27.1	— .5	15.2	1.3	— 1.1	— 3.0	— 1.1	— 1.6	— 1.0
22	1.8	5.6	19.0	25.5	— .5	13.5	2.0	— 1.6	— 2.9	— 1.3	+ 1.2	+ 3.8
23	1.6	5.4	19.2	23.3	+ .1	13.8	1.9	— 1.9	— 2.7	— 1.0	.0	+ 5.0
24	1.4	4.5	18.1	21.3	.2	18.5	1.4	— 2.0	— 1.3	— .2	+ 1.7	+ 6.0
25	1.2	5.0	15.2	19.4	.3	21.5	.7	— .1	— 1.7	— .8	+ 2.3	+ 6.6
26	1.1	5.0	11.4	17.3	2.3	24.1	.1	+ 1.2	— 2.0	+ 1.0	+ 2.8	+ 6.8
27	.9	3.9	7.8	14.8	2.4	25.0	1.8	+ .6	— 2.2	+ 5.1	+ 3.3	+ 6.1
28	.7	4.2	4.6	11.8	2.2	21.8	5.0	— .3	— 2.4	+ 5.6	+ 3.8	+ 5.0
29	.6	......	3.9	9.5	1.6	23.5	7.2	— 1.1	......	+ 3.0	......	+ 4.0
30	.5	......	3.1	9.4	1.0	21.7	5.9	— 1.0	— 2.5	+ 4.6	+ 3.9	+ 4.2
31	.4	......	3.3	......	.8	....	6.7	— 1.4	— 2.5	+ 4.0	+ 3.8	+ 4.8

The following discharge measurements were made during 1901 by K. T. Thomas:

March 11—Gage height, 12.33 feet; discharge, 19,425 second-feet.
April 16—Gage height, 1.10 feet; discharge, 3,926 second-feet.
June 25—Gage height, —2.50; discharge, 698 second-feet.
Oct. 30—Gage height, —3.00; discharge, 657 second-feet.

Daily gage height in feet of Tombigbee River at Columbus, Miss., for 1901.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.
1..........	4.0	6.0	0.9	2.6	0.9	1.3	— 1.6	— 3.2	— 0.4	— 2.3	— 3.0	— 2.2
2..........	3.7	5.9	0.8	6.4	0.5	3.1	— 2.4	— 3.4	— 0.9	— 2.0	— 3.0	— 2.2
3..........	3.2	6.8	2.2	8.0	0.2	3.8	— 2.4	— 3.5	— 1.3	— 2.2	— 3.0	— 2.3
4..........	2.6	12.3	2.4	7.1	0.0	3.9	— 2.1	— 3.4	— 1.6	— 2.2	— 2.9	— 2.3
5..........	1.8	13.2	2.1	6.8	— 0.3	3.5	— 2.4	— 3.3	— 1.6	— 2.5	— 2.9	— 2.2
6..........	1.0	13.9	1.8	6.2	— 0.5	3.1	— 1.6	— 3.2	— 1.9	— 2.5	— 2.9	— 2.2
7..........	0.7	15.1	1.4	5.3	— 0.6	2.8	— 2.6	— 3.0	— 2.0	— 2.6	— 3.0	— 2.2
8..........	0.1	15.9	1.2	4.0	— 0.9	1.9	— 2.6	— 2.8	— 2.2	— 2.7	— 2.8	— 2.1
9..........	0.0	15.6	1.0	2.9	— 1.0	1.4	— 2.7	— 2.8	— 2.3	— 2.7	— 2.8	— 2.0
10..........	0.3	14.5	8.8	2.0	— 1.1	1.0	— 2.8	— 2.9	— 2.4	— 2.8	— 2.8	— 1.8
11..........	10.9	13.0	12.1	1.4	— 1.2	—0.1	— 2.8	— 2.9	— 2.5	— 2.8	— 2.7	— 1.1
12..........	16.9	12.5	14.0	0.9	— 1.2	—0.7	— 2.9	— 3.1	— 2.5	— 2.8	— 2.8	— 0.5
13..........	19.4	12.4	17.8	0.7	— 0.4	—1.0	— 3.0	— 3.0	— 2.4	— 2.6	— 2.8	+ 0.1
14..........	21.7	11.0	19.4	0.7	+ 3.3	—0.9	— 3.1	— 3.2	— 2.1	— 2.5	— 2.8	4.5
15..........	22.7	8.9	19.0	0.9	4.4	—0.8	— 3.1	— 1.5	— 1.8	— 2.2	— 2.8	9.5
16..........	22.3	6.0	17.1	1.2	4.4	—0.8	— 3.2	+ 4.0	— 1.0	— 2.0	— 2.7	9.8
17..........	20.9	4.4	13.8	1.5	3.6	—0.8	— 3.2	11.5	— 0.2	— 2.0	— 2.7	9.2
18..........	18.8	3.3	10.8	6.0	2.7	—1.0	— 3.0	12.4	+ 2.5	— 2.2	— 2.[illegible]	9.8
19..........	16.0	2.7	8.0	11.8	2.1	—1.2	— 3.0	12.4	3.4	— 2.3	— 2.6	10.0
20..........	13.6	2.2	6.3	12.4	2.1	—1.7	— 3.0	14.0	3.5	— 2.4	— 2.5	8.8
21..........	9.4	1.8	4.6	12.7	6.3	—2.0	— 2.0	15.6	2.6	— 2.5	— 2.4	5.9
22..........	6.2	1.5	3.5	13.5	6.[illegible]	—2.2	— 1.9	15.9	1.4	— 2.6	— 2.2	4.8
23..........	3.8	1.2	3.2	13.5	6.3	—2.4	— 2.3	14.8	0.4	— 2.7	— 2.3	2.4
24..........	3.0	1.0	3.1	11.8	5.3	—2.5	— 2.5	12.1	— 0.6	— 2.8	— 2.1	1.4
25..........	5.9	1.0	2.8	8.2	4.0	—2.5	— 2.6	8.9	— 1.2	— 2.9	— 2.0	0.8
26..........	6.5	1.1	2.5	5.1	2.2	—2.6	— 2.9	6.5	— 1.6	— 2.9	— 1.9	0.7
27..........	6.3	1.2	2.2	3.4	1.5	—2.6	— 3.0	4.1	— 1.9	— 2.9	— 1.8	1.1
28..........	6.0	1.0	1.9	2.5	1.8	—2.6	— 3.1	2.0	— 2.1	— 2.9	— 1.8	1.0
29..........	5.8	......	1.6	1.8	1.7	—2.7	— 3.2	1.6	— 2.2	— 3.0	— 2.0	9.0
30..........	5.7	......	1.4	1.3	1.2	—2.6	— 3.3	1.1	— 2.3	— 3.0	— 2.1	11.0
31..........	5.5	......	2.3	......	0.9	.....	— 3.4	0.3	......	— 3.0	......	9.6

Rating table for Tombigbee River at Columbus, Miss., for 1900 and 1901.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second ft.*	*Feet.*	*Second ft.*	*Feet.*	*Second ft.*	*Feet.*	*Second ft.*
—3.0	650	1.0	3,790	5.0	9,310	9.0	14,830
—2.9	668	1.1	3,928	5.1	9,448	9.1	14,968
—2.8	688	1.2	4,066	5.2	9,586	9.2	15,106
—2.7	712	1.3	4,204	5.3	9,724	9.3	15,244
—2.6	736	1.4	4,342	5.4	9,862	9.4	15,382
—2.5	752	1.5	4,480	5.5	10,000	9.5	15,520
—2.4	780	1.6	4,618	5.6	10,138	9.6	15,658
—2.3	810	1.7	4,756	5.7	10,276	9.7	15,796
—2.2	842	1.8	4,894	5.8	10,414	9.8	15,934
—2.1	877	1.9	5,032	5.9	10,552	9.9	16,072
—2.0	915	2.0	5,170	6.0	10,690	10.0	16,210
—1.9	956	2.1	5,308	6.1	10,828	10.1	16,348
—1.8	1,000	2.2	5,446	6.2	10,966	10.2	16,486
—1.7	1,047	2.3	5,584	6.3	11,104	10.3	16,624
—1.6	1,097	2.4	5,722	6.4	11,242	10.4	16,762
—1.5	1,150	2.5	5,860	6.5	11,380	10.5	16,900
—1.4	1,206	2.6	5,998	6.6	11,518	10.6	17,038
—1.3	1,265	2.7	6,136	6.7	11,656	10.7	17,176
—1.2	1,328	2.8	6,274	6.8	11,794	10.8	17,314
—1.1	1,394	2.9	6,412	6.9	11,932	10.9	17,452
—1.0	1,464	3.0	6,550	7.0	12,070	11.0	17,590
—0.9	1,537	3.1	6,688	7.1	12,208	11.5	18,280
—0.8	1,613	3.2	6,826	7.2	12,346	12.0	18,970
—0.7	1,692	3.3	6,964	7.3	12,484	12.5	19,660
—0.6	1,775	3.4	7,102	7.4	12,622	13.0	20,350
—0.5	1,863	3.5	7,240	7.5	12,760	13.5	21,040
—0.4	1,957	3.6	7,378	7.6	12,898	14.0	21,730
—0.3	2,057	3.7	7,516	7.7	13,036	14.5	22,420
—0.2	2,165	3.8	7,654	7.8	13,174	15.0	23,110
—0.1	2,283	3.9	7,792	7.9	13,312	15.5	23,800
0.0	2,410	4.0	7,930	8.0	13,450	16.0	24,490
0.1	2,548	4.1	8,068	8.1	13,588	16.5	25,180
0.2	2,686	4.2	8,206	8.2	13,726	17.0	25,870
0.3	2,824	4.3	8,344	8.3	13,864	17.5	26,560
0.4	2,962	4.4	8,482	8.4	14,002	18.0	27,250
0.5	3,100	4.5	8,620	8.5	14,140	18.5	27,940
0.6	3,238	4.6	8,758	8.6	14,278	19.0	28,630
0.7	3,376	4.7	8,896	8.7	14,416	19.5	29,320
0.8	3,514	4.8	9,034	8.8	14,554	20.0	30,010
0.9	3,652	4.9	9,172	8.9	14,692		

Estimated monthly discharge of Tombigbee River at Columbus, Miss.
[Drainage area, 4,440 square miles.]

Month	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Depth in inches.	Second feet per square mile.
1900.					
January	13,864	2,962	5,588	1.26	1.45
February	16,486	2,686	8,659	1.95	2.03
March	23,938	6,688	15,285	3.42	3.85
April	40,498	3,100	21,265	4.79	5.34
May	13,450	1,464	4,944	1.11	1.28
June	37,600	37,90	27,692	6.24	6.96
July	29,596	2,410	11,411	2.57	2.97
August	10,414	707	2,257	.51	.59
September	1,775	632	950	.21	.23
October	10,138	566	3,989	.90	1.04
November	10,000	1,097	4,304	.97	1.08
December	11,794	1,464	5,239	1.18	1.36
The year	40,498	566	9,299	2.09	28.18
1901.					
January	33,736	2,410	14,193	3.20	3.69
February	24,352	3,790	12,533	2.83	2.95
March	29,182	3,514	10,884	2.45	2.33
April	21,040	3,376	9,890	2.23	2.49
May	11,656	1,328	4,949	1.11	1.28
June	7,792	707	2,767	.62	.69
July	10,97	582	730	.16	.18
August	24,352	582	7,673	1.73	1.99
September	7,240	753	2,008	.45	.50
October	915	650	748	.17	.20
November	1,000	650	756	.17	.19
December	17,590	810	6,730	1.52	1.75
The year	33,736	582	6,155	1.39	18.74

Minimum monthly discharge of Tombigbee River at Columbus, Miss., with corresponding net horse power per foot of fall on a water wheel realizing 80 *per cent. of the theoretical power.*
[Drainage area, 4,440 square miles.]

	1900			1901		
	Minimum cubic feet per second.	Minimum net H. P. per foot of fall.	No. of days duration of minimum.	Minimum cubic feet per second.	Minimum net H. P. per foot fall.	No. of days duration of minimum.
January	2,962	269	1	2,410	219	1
February	2,686	244	1	3,790	345	3
March	6,688	608	1	3,514	319	1
April	3,100	282	1	3,376	307	2
May	1,464	133	1	1,328	121	2
June	3,790	345	1	707	65	1
July	2,410	219	1	582	53	1
August	707	65	1	582	53	1
September	632	57	1	753	68	2
October	566	51	2	650	59	3
November	1,097	100	4	650	59	4
December	1,464	133	4	810	74	2

NOTE.—To find the minimum net horse power available at a shoal on this stream, near this station, for any month, multiply the to fall of the shoal by the "Net H. P. per foot of fall" in this table fo that month.

2. TOMBIGBEE RIVER NEAR EPES, ALABAMA.

A record of gage heights has been kept at this station for the last ten years by the Alabama Great Southern Railway Company. The gage is painted on the center brick pier of the railway bridge of that company across the Tombigbee a half mile east of Epes, and is referred to two bench marks, the first, the top of the iron girder at the third cross-beam at the station, 80 feet from the right-bank end of the iron bridge, is 64.70 feet above datum of gage; the second, the top of the cross-tie or the base of the rail at the station, 80 feet from the right-bank end of he iron bridge, is 65.50 feet above datum of gage. The west bank of the river is a solid wall of limestone, the east bank is flat and is subject to overflow. The trestle at the east end of the bridge is seven-eighths of a mile long. The section is good, though the water is very deep and rather swift.

Daily gage height in feet of Tombigbee River near Epes, Ala.. for 1900.

Day	Jan.	Feb.	Mar.	April	May	Jun	July	Aug.	Sept.	Oct.	Nov.	De
1	8.5	3.0	18.0	24.5	43.0	6.0	44.5	14.5	2.0	0.5	7.0	8.0
2	7.5	3.0	19.0	19.5	41.0	8.0	44.5	12.0	2.5	.5	8.0	7.5
3	6.5	3.0	18.0	16.0	39.0	15.0	44.5	10.5	2.0	.5	9.0	7.0
4	6.0	3.0	17.0	12.0	33.5	21.0	44.0	8.0	2.0	.5	8.5	6.0
5	5.5	5.0	15.0	10.0	28.0	24.5	42.5	6.0	2.0	.5	8.5	5.0
6	5.0	6.0	14.0	8.0	20.5	27.0	42.0	5.0	2.0	.5	7.5	4.5
7	4.5	7.0	13.0	7.5	16.0	29.5	41.0	5.0	2.0	.5	7.0	4.0
8	4.0	7.5	18.0	7.5	10.0	32.0	40.0	4.0	2.0	.5	5.5	4.0
9	3.5	11.5	21.0	7.0	7.0	34.5	39.0	3.0	2.0	.5	4.5	4.0
10	3.5	13.5	23.0	6.5	7.0	37.0	38.0	2.0	2.0	2.0	4.0	3.5
11	13.0	15.0	24.0	20.5	7.0	38.5	34.0	2.0	1.5	4.0	4.0	3.0
12	20.0	20.5	24.0	26.0	8.0	39.5	26.0	2.0	1.5	6.0	3.0	3.0
13	23.0	26.0	23.0	29.0	8.0	40.5	23.0	2.0	1.5	7.5	3.0	3.5
14	23.5	28.0	20.0	30.0	7.0	41.0	15.5	2.0	2.0	8.5	2.5	3.5
15	22.0	28.0	17.5	31.0	6.0	41.5	13.0	2.0	1.5	10.0	2.0	3.5
16	21.0	26.0	17.0	38.0	6.0	42.0	8.0	1.5	1.0	10.5	2.0	3.0
17	18.5	24.0	18.0	46.0	5.0	42.0	7.0	1.5	1.0	10.0	2.0	3.0
18	15.0	22.0	18.0	48.5	4.0	42.0	6.0	1.5	1.0	7.5	2.0	3.0
19	11.5	18.5	18.5	51.0	3.5	41.5	5.0	1.5	1.0	5.0	2.5	3.0
20	10.0	16.0	26.0	51.5	3.5	41.5	6.5	1.5	.5	4.0	2.5	6.0
21	8.5	14.0	30.0	52.0	3.5	41.5	7.0	1.0	.5	3.5	3.0	5.0
22	8.0	15.0	32.0	52.0	3.5	41.0	8.0	1.0	.5	3.0	3.5	5.0
23	8.0	17.5	34.0	51.5	3.5	41.0	9.0	2.0	.5	2.0	3.5	8.5
24	7.0	18.0	35.5	51.0	4.0	42.5	8.0	1.5	.5	2.0	3.5	10.0
25	6.5	[illegible]	37.5	49.5	4.5	42.5	6.0	1.5	.5	3.0	6.5	11.5
26	6.0	17.0	38.0	47.5	5.0	43.5	5.5	1.5	.5	4.0	8.5	11.5
27	5.0	16.0	39.0	47.0	6.0	43.5	5.0	5.0	.5	4.5	7.5	12.5
28	3.0	17.0	38.5	46.5	7.0	43.5	5.5	4.5	.5	7.5	7.5	12.0
29	3.0	......	35.0	46.0	7.0	44.0	14.0	4.0	.5	9.0	8.0	10.0
30	3.0	......	33.0	44.5	6.0	44.5	14.5	3.0	.5	8.0	8.5	10.0
31	3.0	......	30.0	......	5.0	....	14.5	2.0	......	7.5	......	10.5

The following discharge measurements were made during 1901 by K. T. Thomas:

Jan. 31—Gage height, 12.70 feet; discharge, 13,738 second-feet.
March 14—Gage height, 21.10 feet; discharge, 23,824 second-feet.
June 28—Gage height, 1.00 feet; discharge, 1,496 second-feet.
Nov. 13—Gage height, 0.70 feet; discharge, 1,290 second-feet.

Daily gage height in feet of Tombigbee River near Epes, Ala., for 1901.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.
1..........	10.0	12.0	6.5	13.0	7.5	5.5	1.0	......	5.5	1.5	0.7	1.7
2..........	10.0	10.5	6.5	13.5	7.0	6.0	1.0	......	4.0	6.0	0.7	1.7
3..........	9.0	16.8	9.0	15.5	6.0	7.0	1.0	......	3.5	2.5	0.7	1.7
4..........	8.0	21.5	9.0	18.0	5.0	9.0	1.0	......	2.5	1.5	0.0	3.5
5..........	7.0	25.5	8.5	17.0	4.5	9.0	1.0	......	2.0	1.5	0.0	2.0
6..........	6.0	26.5	7.0	16.0	5.0	11.0	1.0	......	2.0	1.5	0.0	2.0
7..........	5.5	27.5	6.5	15.0	4.0	12.0	1.0	......	1.5	1.5	0.0	2.0
8..........	5.0	29.0	6.5	14.0	3.5	10.0	1.0	......	1.5	1.0	0.0	3.5
9..........	4.5	30.5	6.5	11.0	3.5	8.	1.0	......	1.5	1.0	0.7	5.9
10..........	4.0	31.0	13.0	9.5	3.0	6.5	1.0	......	1.5	1.0	0.7	6.5
11..........	18.0	31.0	18.0	8.0	3.0	5.5	0.5	......	1.5	1.0	0.7	5.5
12..........	29.5	31.0	19.5	7.5	3.5	4.	0.5	......	1.5	1.0	0.7	4.7
13..........	33.0	30.0	20.0	9.0	4.0	4.	0.5	......	1.0	1.0	0.7	4.2
14..........	35.0	29.5	24.5	8.0	7.0	3.	0.5	......	1.0	1.0	0.7	13.0
15..........	36.0	28.5	25.5	7.0	8.0	3.	0.5	......	1.0	1.0	0.7	19.5
16..........	38.0	26.0	26.5	7.0	8.5	[illegible]	0.5	8.5	1.5	1.0	0.7	22.0
17..........	39.0	23.0	26.5	6.5	8.0	3.0	0.5	15.0	2.0	1.0	1.0	23.0
18..........	39.5	16.0	26.0	20.0	7.0	3.0	0.5	20.0	2.5	1.0	1.7	22.5
19..........	40.0	12.0	25.0	28.0	6.5	2.5	0.5	22.5	6.0	1.0	1.7	22.0
20..........	40.5	1.00	23.0	29.5	9.0	2.0	1.0	23.0	......	1.0	1.5	20.0
21..........	39.0	8.5	20.0	30.0	12.0	2.0	1.0	24.0	7.5	1.0	1.5	18.0
22..........	38.0	8.0	17.0	29.5	12.0	2.0	1.0	24.5	7.5	1.0	1.7	14.0
23..........	34.5	7.5	12.5	28.5	11.5	1.5	1.0	26.0	7.0	1.0	1.7	12.0
24..........	29.0	7.0	11.0	28.0	11.0	1.2	1.0	26.5	5.5	0.5	1.8	9.0
25..........	24.5	6.5	12.0	27.0	10.0	1.0	1.0	26.0	4.0	0.5	1.8	8.0
26..........	20.0	6.5	13.5	24.0	8.0	1.0	1.0	25.0	3.0	0.5	2.0	7.0
27..........	16.0	6.5	13.5	18.0	6.5	1.0	0.5	23.0	2.0	0.5	2.0	7.0
28..........	15.0	6.5	11.5	13.0	6.5	1.0	0.5	19.0	1.5	0.5	2.0	12.0
29..........	14.0	......	10.0	11.0	6.5	1.0	— 0.2	12.0	1.5	0.5	1.9	20.0
30..........	13.0	......	9.0	8.0	6.5	1.0	— 0.2	6.5	1.5	0.5	1.8	26.0
31..........	12.7	......	13.5	......	7.0	....	— 0.2	5.5	......	0.5	......	27.0

Rating table for Tombigbee River at Epes, Ala., for 1900-1901.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-ft.*	*Feet.*	*Second-ft.*	*Feet.*	*Second-ft.*	*Feet.*	*Second-ft.*
—0.2	810	5.4	5,208	11.0	11,700	16.6	18,420
—0.1	840	5.5	5,308	11.1	11,820	16.7	18,540
0.0	880	5.6	5,409	11.2	11,940	16.8	18,660
0.1	830	5.7	5,511	11.3	12,060	16.9	18,780
0.2	985	5.8	5,613	11.4	12,180	17.0	18,900
0.3	1,043	5.9	5,716	11.5	12,300	17.1	19,020
0.4	1,103	6.0	5,820	11.6	12,420	17.2	19,140
0.5	1,164	6.1	5,925	11.7	12,540	17.3	19,260
0.6	1,226	6.2	6,030	11.8	12,660	17.4	19,380
0.7	1,289	6.3	6,136	11.9	12,780	17.5	19,500
0.8	1,353	6.4	6,243	12.0	12,900	17.6	19,620
0.9	1,418	6.5	6,350	12.1	13,020	17.7	19,740
1.0	1,484	6.6	6,458	12.2	13,140	17.8	19,860
1.1	1,551	6.7	6,566	12.3	13,260	17.9	19,980
1.2	1,619	6.8	6,675	12.4	13,380	18.0	20,100
1.3	1,688	6.9	6,785	12.5	13,500	18.1	20,220
1.4	1,758	7.0	6,900	12.6	13,620	18.2	20,340
1.5	1,829	7.1	7,020	12.7	13,740	18.3	20,460
1.6	1,903	7.2	7,140	12.8	13,860	18.4	20,580
1.7	1,976	7.3	7,260	12.9	13,980	18.5	20,700
1.8	2,050	7.4	7,380	13.0	14,100	18.6	20,020
1.9	2,125	7.5	7,500	13.1	14,220	18.7	20,940
2.0	2,200	7.6	7,620	13.2	14,340	18.8	21,060
2.1	2,276	7.7	7,740	13.3	14,460	18.9	21,180
2.2	2,353	7.8	7,860	13.4	14,580	19.0	21,300
2.3	2,431	7.9	7,980	13.5	14,700	19.1	21,420
2.4	2,510	8.0	8,100	13.6	14,820	19.2	21,540
2.5	2,590	8.1	8,220	13.7	14,940	19.3	21,660
2.6	2,671	8.2	8,340	13.8	15,060	19.4	21,780
2.7	2,753	8.3	8,460	13.9	15,180	19.5	21,900
2.8	2,835	8.4	8,580	14.0	15,300	19.6	22,020
2.9	2,918	8.5	8,700	14.1	15,420	19.7	22,140
3.0	3,002	8.6	8,820	14.2	15,540	19.8	22,260
3.1	3,087	8.7	8,940	14.3	15,660	19.9	22,380
3.2	3,172	8.8	9,060	14.4	15,780	20.0	22,500
3.3	3,258	8.9	9,180	14.5	15,900	20.1	22,620
3.4	3,345	9.0	9,300	14.6	16,020	20.2	22,740
3.5	3,432	9.1	9,420	14.7	16,140	20.3	22,860
3.6	3,520	9.2	9,540	14.8	16,260	20.4	22,980
3.7	3,609	9.3	9,660	14.9	16,380	20.5	23,100
3.8	3,698	9.4	9,780	15.0	16,500	20.6	23,220
3.9	3,788	9.5	9,900	15.1	16,620	20.7	23,340
4.0	3,878	9.6	10,020	15.2	16,740	20.8	23,460
4.1	3,969	9.7	10,140	15.3	16,860	20.9	23,580
4.2	4,060	9.8	10,260	15.4	16,980	21.0	23,700

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-ft.*	*Feet.*	*Second-ft.*	*Feet*	*Second-ft.*	*Feet.*	*Second-feet.*
4.3	4,152	9.9	10,380	15.5	17,100	21.1	23,820
4.4	4,245	10.0	10,500	15.6	17,220	21.2	23,940
4.5	4,338	10.1	10,620	15.7	17,340	21.3	24,060
4.6	4,432	10.2	10,740	15.8	17,460	21.4	24,180
4.7	4,527	10.3	10,860	15.9	17,580	21.5	24,300
4.8	4,622	10.4	10,980	16.0	17,700	21.6	24,420
4.9	4,718	10.5	11,100	16.1	17,820	21.7	24,540
5.0	4,815	10.6	11,220	16.2	17,940	21.8	24,660
5.1	4,912	10.7	11,340	16.3	18,060	21.9	24,780
5.2	5,010	10.8	11,460	16.4	18,180	22.0	24,900
5.3	5,109	10.9	11,580	16.5	18,300		

NOTE.—This table applied to the foregoing "Daily gage heights" gives the cubic feet per second flowing in the river on each date for which the gage height is given.

Estimated monthly discharge of Tombigbee River at Epes, Ala.

[Drainage area, 8,830 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1901.					
January	47,100	3,878	25,579	2.90	3.34
February	35,700	6,350	20,999	2.38	2.48
March	30,300	6,350	16,198	1.83	2.11
April	34,500	6,350	18,102	2.05	2.29
May	12,900	3,002	6,880	.78	.90
June	12,900	1,484	4,585	.52	.58
July	1,484	810	1,295	.15	.17
August 16-31	....	....	21,541	2.44	1.41
September	7,500	1,484	3,205	.36	.40
October	5,820	1,164	1,633	.18	.21
November	2,200	880	1,550	.18	.20
December	30,900	1,960	12,249	1.39	1.60

Minimum monthly discharge of Tombigbee River at Epes, Ala., with corresponding net horse power per foot of fall on a water wheel realizing 80 per cent. of the theoretical power.

[Drainage area, 8,830 square miles.]

	1900.			1901.		
	Minimum cubic fee per second.	Minimum net H. P. per foot of fall.	No. of days duration of minimum.	Minimum cubic feet per second.	Minimum net H. P. per foot fall.	No. of days duration of minimum.
January	3,002	273	4	3,878	353	1
February	3,002	273	4	6,350	577	4
March	14,100	1,282	1	6,350	577	5
April	6,350	577	1	6,350	577	1
May	3,432	312	5	3,002	273	2
June	5,820	529	1	1,484	135	6
July	4,815	438	2	810	74	3
August	1,484	135	2	......	......	....
September	1,164	106	11	1,484	135	3
October	1,164	106	9	1,164	106	8
November	2,200	200	4	880	80	5
December	3,002	273	5	1,960	178	3

NOTE—To find the minimum net horse power available at a shoal on this stream, near this station, for any month, multiply the total fall of the shoal by the "net H. P. per foot of fall" in this table for that month.

3. TRIBUTARIES.

There are several large creeks in Marion and Lamar Counties that flow into Mississippi, and enter the Tombigbee River near Columbus. One of these, the Buttahatchee Creek, in Marion County, has numerous rapids, especially near the crossing of the Military Road.

Luxapalila Creek, in Lamar County, has two prongs that are both good power streams. They come together before the creek enters Mississippi, making Big Luxapalila Creek, which enters the Tombigbee at Columbus, Miss. The following measurements have been made on this stream at Columbus, Miss.:

1901.
March 11—Gage height, 8.20 feet; discharge, 2,459 second-feet.
April 16—Gage height, 4.45 feet; discharge, 873 second-feet.
June 26—Gage height, 1.90 feet; discharge, 109 second-feet.
Oct. 31—Gage height, 2.00 feet; discharge, 126 second-feet.

CHAPTER VII.

1. TENNESSEE RIVER AT CHATTANOOGA, TENNESSEE.

This river, after passing Chattanooga, enters Alabama. It then makes a bend to the west and later to the north, returning to Tennessee. Flowing through this State and Kentucky, it empties into the Ohio 50 miles above Cairo. In 1879 a gage was established at Chattanooga, Tennessee, at the foot of Lookout street, just below Chattanooga Island, by the Signal Corps of the United States Army, which has been in charge of the Weather Bureau since July 1, 1891. The drainage area above this station is 21,382 square miles, and is mapped on Morristown, Greenville, Roan Mountain, London, Knoxville, Mount Guyot, Asheville, Murphy, Briceville, Standingstone, Wartburg, Pikeville, Maynardville, Cumberland Gap, Jonesville, Estillville, Bristol, Whitesburg, Grundy, Abington, Tazewell, Pocahontas, Wytheville, Cranberry, Morganton, Mount Mitchell, Saluda, Pisgah, Como, Nantahala, Walhalla, Dahlonega, Ellijay, Dalton, Cleveand, Ringgold, Kingston, and Chattanooga atlas sheets. The gage is on an incline railroad iron for about 20 feet of its lower portion. Above this it is a vertical rod, bolted to the rock bluff forming the river bank. The zero of the gage is 630.4 feet above sea level. Measurements are made from the Hamilton County steel highway bridge at the foot of Walnut street, a short distance below the gage. Gage heights are obtained from L. M. Pindell, United States Weather Bureau observer. During the year 1900 a new gage on the same datum was established. It is a vertical rod bolted to the south side of the third stone pier from the south end of the bridge.

Daily gage height of Tennessee River at Chattanooga, Tenn, for 1890.

[Furnished by L. M. Pindell, observer in charge, United States Weather Bureau.]

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.
1..........	4.9	8.0	40.2	10.0	7.5	6.1	3.2	5.8	7.6	9.4	6.8	2.4
2..........	5.2	7.3	42.5	9.8	7.1	6.6	2.9	5.2	5.6	8.1	6.6	2.4
3..........	5.1	7.3	41.0	9.4	6.7	5.3	2.9	4.7	5.7	7.7	5.7	2.3
4..........	5.0	7.4	34.4	9.7	6.8	5.3	3.0	4.7	4.0	7.2	5.3	2.3
5..........	5.0	7.2	23.0	12.2	7.0	5.2	3.0	4.8	3.6	6.4	5.0	2.3
6..........	4.8	7.8	15.1	14.0	7.5	5.3	3.0	4.5	3.2	5.7	4.6	2.5
7..........	4.7	8.3	14.2	13.6	8.9	5.2	3.0	5.2	3.6	5.2	4.4	2.8
8..........	4.6	11.5	14.4	13.4	9.1	4.9	2.9	5.7	3.2	5.2	4.3	2.9
9..........	4.7	19.3	12.8	11.9	8.7	4.7	2.8	6.6	2.8	5.5	4.0	7.1
10..........	4.9	20.4	11.2	10.5	8.7	4.5	2.7	7.5	2.8	5.3	3.9	8.1
11..........	4.7	17.8	10.0	9.6	8.1	4.5	2.7	7.2	3.0	4.8	3.8	8.2
12..........	4.6	14.7	9.2	8.7	7.7	4.4	3.0	6.3	3.4	4.6	3.6	7.7
13..........	4.6	12.0	8.6	8.0	7.2	4.0	2.7	5.8	3.6	4.4	3.5	7.4
14..........	4.9	10.0	8.7	7.5	6.7	3.9	2.5	5.2	4.6	4.2	3.4	6.4
15..........	4.6	9.8	9.7	7.1	6.6	4.0	2.3	4.8	4.0	3.9	3.3	3.7
16..........	5.4	9.6	13.7	6.9	7.8	4.1	2.1	4.2	4.0	3.7	3.2	4.2
17..........	7.2	9.0	15.1	7.1	9.3	4.0	2.0	3.8	3.7	3.7	3.2	3.9
18..........	9.2	9.3	14.9	9.4	8.6	3.9	2.2	3.7	4.0	3.7	3.0	3.9
19..........	8.2	8.5	13.0	16.6	7.9	3.7	4.7	3.3	5.3	4.2	3.2	4.0
20..........	7.5	7.8	11.7	20.4	8.8	3.6	4.7	3.1	3.7	4.0	3.1	4.0
21..........	7.0	7.3	12.4	18.2	10.7	3.7	4.1	2.6	3.7	4.0	3.1	3.9
22..........	9.6	7.1	14.0	14.3	11.9	3.8	3.5	2.5	5.8	3.8	3.1	3.9
23..........	13.0	7.2	20.0	11.3	11.9	3.7	3.2	3.8	3.5	5.3	2.9	3.9
24..........	12.3	7.4	25.5	9.6	11.6	3.8	3.2	4.0	3.3	7.2	2.8	3.9
25..........	11.7	12.1	27.2	8.7	9.2	4.0	4.1	3.3	3.4	8.8	2.8	4.3
26..........	10.0	18.7	26.0	8.4	7.8	4.0	5.9	3.8	4.0	9.2	2.7	4.6
27..........	8.3	26.4	21.4	8.4	7.4	3.9	7.5	3.6	4.3	9.5	2.6	9.4
28..........	7.3	34.8	15.4	8.5	8.0	3.9	7.7	3.0	4.0	8.6	2.6	12.5
29..........	6.6	......	13.0	8.4	8.1	3.5	7.0	3.8	3.8	7.6	2.5	12.9
30..........	7.7	......	11.9	8.1	7.4	3.1	6.3	5.4	5.3	7.1	2.4	12.4
31..........	8.3	......	10.7	......	6.8	....	6.2	6.5	......	7.0	......	9.3

Daily gage height of Tennessee River at Chattanooga, Tenn. for 1891.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec
1..........	7.7	9.8	18.6	15.4	5.9	5.8	3.9	8.3	5.4	1.8	1.3	3.
2..........	7.8	13.2	17.5	16.3	5.7	5.6	3.8	10.3	4.7	1.9	1.3	3.2
3..........	9.9	16.1	15.6	16.3	5.6	5.3	3.6	15.1	4.3	1.9	1.3	2.9
4..........	14.1	19.8	13.3	15.7	5.5	4.8	3.6	16.4	4.2	1.8	1.2	2.8
5..........	15.5	22.6	15.4	15.1	5.2	4.4	3.6	12.0	5.1	1.8	1.2	5.6
6..........	15.2	21.6	20.0	12.6	5.1	4.1	3.6	8.7	5.1	1.7	1.2	6.1
7..........	10.4	18.3	23.6	11.6	4.9	3.9	3.4	6.9	5.2	1.7	1.2	6.6
8..........	8.2	16.9	29.1	10.8	4.7	4.1	3.4	5.8	5.2	1.6	1.2	8.6
9..........	7.1	14.5	34.5	9.8	4.6	4.6	3.3	5.1	5.8	1.7	1.2	10.8
10..........	6.3	21.0	37.5	9.6	4.5	4.7	4.5	4.6	4.9	1.7	1.2	10.9
11..........	6.5	27.8	38.9	9.8	4.4	5.5	5.1	4.4	4.4	1.8	1.5	10.3
12..........	8.9	34.3	37.6	9.9	4.3	7.0	4.4	4.0	3.9	1.8	1.7	8.5
13..........	10.7	36.5	33.5	10.6	4.2	6.5	3.9	4.0	3.6	1.7	2.7	6.8
14..........	10.0	37.5	27.0	11.3	4.1	5.7	3.5	3.9	3.5	1.7	3.6	5.7
15..........	9.2	35.5	22.2	12.2	4.2	5.5	3.1	3.8	3.5	1.7	4.1	5.1
16..........	7.3	29.0	19.8	10.8	4.2	5.7	2.9	3.6	3.5	1.6	3.5	5.0
17..........	7.8	21.1	18.1	9.4	4.5	5.8	2.8	3.5	3.5	1.6	2.8	5.2
18..........	7.5	19.7	15.3	8.4	4.7	6.1	2.7	3.4	3.2	1.5	2.5	5.3
19..........	7.5	18.2	13.5	8.2	4.7	6.8	4.1	3.0	2.9	1.5	2.4	4.8
20..........	7.6	16.5	12.3	7.9	4.6	7.3	5.0	3.0	2.7	1.5	2.5	4.5
21..........	7.5	15.5	11.3	7.9	4.5	6.8	4.5	3.4	2.6	1.5	2.3	4.2
22..........	8.2	18.8	10.8	7.6	4.3	6.8	4.0	4.0	2.5	1.5	2.4	4.0
23..........	12.5	24.0	10.7	7.4	4.1	6.5	3.8	4.6	2.4	1.5	3.0	3.8
24..........	15.3	27.7	10.8	7.4	4.0	7.1	3.6	5.5	2.3	1.5	4.6	3.7
25..........	14.0	29.0	10.6	7.5	3.8	7.4	3.5	5.6	2.2	1.5	6.2	4.1
26..........	13.6	26.7	10.4	7.5	3.9	7.6	3.5	7.7	2.2	1.5	6.7	4.9
27..........	11.2	20.6	10.5	7.4	4.0	6.2	3.5	8.2	2.1	1.5	6.3	8.1
28..........	9.7	19.0	14.1	7.2	4.1	4.9	3.6	8.1	2.0	1.5	5.6	10.2
29..........	7.9	......	13.6	6.5	4.1	4.3	3.7	7.0	1.9	1.4	4.7	9.6
30..........	7.9	......	13.0	6.2	4.7	4.1	3.8	6.4	1.9	1.4	4.0	8.4
31..........	8.9	......	13.1	......	5.3	....	5.7	6.1	......	1.4	......	7.8

Daily gage height of Tennessee River at Chattanooga, Tenn, for 1892.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec
1..........	6.6	6.5	5.7	9.1	8.7	5.6	6.6	4.2	2.1	2.2	1.1	4.1
2..........	6.6	6.2	5.6	8.3	8.2	5.4	5.6	4.1	1.8	2.0	1.2	4.0
3..........	8.1	6.0	5.5	7.4	7.6	5.5	5.5	4.2	1.7	1.9	1.2	3.8
4..........	8.8	5.8	5.3	6.8	7.3	5.8	5.4	4.0	1.5	1.8	1.6	3.7
5..........	8.7	5.5	5.1	6.5	7.4	8.8	6.6	4.1	1.3	1.7	2.0	3.6
6..........	8.4	5.4	5.0	8.5	7.0	9.2	8.9	4.9	2.2	1.6	2.3	3.6
7..........	9.0	5.3	4.9	21.7	6.6	9.3	11.2	4.2	2.1	1.6	2.4	3.3
8..........	9.8	5.8	5.0	31.6	6.3	8.7	11.8	3.8	2.0	1.5	2.4	3.2
9..........	10.0	8.1	6.0	34.2	6.2	8.6	10.1	3.5	2.0	1.5	2.9	3.2
10..........	9.3	11.5	7.1	34.3	5.9	8.3	8.6	3.3	1.9	1.5	4.4	3.0
11..........	8.1	11.3	8.0	31.0	5.5	7.8	9.0	3.3	2.0	1.5	5.9	2.9
12..........	8.3	10.5	7.9	26.6	5.7	8.0	9.5	3.1	1.8	1.5	6.6	2.7
13..........	11.2	8.9	7.6	18.0	5.7	8.1	9.4	3.5	2.1	1.4	7.0	2.6
14..........	22.9	7.7	7.6	12.9	5.5	7.8	8.9	3.6	2.1	1.4	4.4	2.6
15..........	32.9	7.2	6.8	11.7	5.3	6.0	8.7	3.7	2.1	1.4	4.2	3.3
16..........	37.1	7.4	6.2	10.9	5.2	5.3	8.5	3.5	3.1	1.4	4.8	3.4
17..........	37.9	8.0	5.9	10.0	5.1	4.8	8.4	3.1	4.5	1.4	5.6	5.3
18..........	35.2	7.9	6.5	9.4	4.8	4.4	8.1	2.9	4.1	1.3	6.2	8.1
19..........	26.3	7.5	7.5	8.8	5.1	4.4	7.5	2.8	3.5	1.3	6.4	8.7
20..........	18.7	7.7	8.2	12.3	5.5	4.3	7.2	2.8	3.0	1.2	6.2	8.4
21..........	19.0	7.9	8.2	16.2	6.1	7.0	6.9	3.0	2.8	1.2	5.5	9.1
22..........	19.0	8.9	7.8	16.3	6.5	7.8	6.2	2.9	3.0	1.2	4.8	9.3
23..........	17.4	8.9	7.6	15.5	6.9	7.4	5.6	2.9	2.6	1.2	4.4	8.9
24..........	14.9	8.4	8.4	14.8	7.1	7.1	5.4	3.0	2.3	1.2	4.2	7.8
25..........	12.2	7.9	9.6	13.5	7.6	6.9	5.2	2.7	2.3	1.2	3.9	6.7
26..........	10.5	7.5	9.5	13.7	7.8	6.8	5.0	2.8	3.6	1.1	3.4	5.8
27..........	9.7	6.7	10.0	13.6	6.7	6.7	4.6	3.2	3.6	1.1	3.1	5.2
28..........	8.5	6.4	10.6	10.4	6.2	7.3	4.5	3.6	3.1	1.1	3.0	4.8
29..........	7.7	5.9	10.3	9.1	5.8	7.5	4.3	4.4	2.6	1.1	3.0	4.3
30..........	6.9	......	9.7	8.8	5.7	7.2	4.1	3.8	2.4	1.1	3.6	3.9
31..........	6.8	......	9.4	......	5.6	....	3.8	3.3	......	1.1	......	3.3

*List of discharge measurements made on Tennessee River at Chattanooga, Tennessee.**

No.	Date.	Hydrographer.	Meter No	Gage height, feet.	Area of section, (square feet.)	Mean velocity (ft. per sec.)	Discharge (second-feet.)
1	March 15	L. M. Pindell ...	2	10.3	17,971	....	63,039
2	March 16	do ...	2	9.2	16,847	....	58,310
3	April 3	do ...	2	5.1	12,427	....	32,628
4	April 4	do ...	2	5.1	12,427	....	32,643
5	May 5	do ...	2	26.0	36,648	3.93	156,187
6	May 8	do ...	2	26.0	36,825	3.73	151,660
7	May 9	do ...	2	16.0	24,913	3.75	96,979
8	May 17	do ...	2	9.9	17,971	3.39	65,867
9	May 18	do ...	2	10.4	18,539	3.29	67,883

*Meter submerged at one-half depth.

Daily gage height of Tennessee River at Chattanooga, Tenn., for 1893.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.
1..........	3.4	10.4	8.4	5.5	10.2	7.4	3.9	2.6	8.4	2.6	3.1	2.5
2..........	3.8	12.1	9.1	5.3	9.6	8.0	3.8	2.5	6.8	2.5	3.0	3.9
3..........	4.7	10.6	8.9	5.1	11.0	10.0	4.2	3.1	5.0	2.4	2.8	3.7
4..........	5.7	8.6	8.9	5.1	18.4	8.1	5.2	3.5	6.2	2.4	2.7	4.1
5..........	5.6	8.0	8.7	5.1	24.5	6.6	4.8	3.3	6.0	2.6	2.6	4.3
6..........	5.3	7.7	9.0	5.2	28.2	8.3	3.9	3.2	4.9	2.5	2.5	4.7
7..........	5.2	7.0	9.1	5.4	30.0	16.0	3.8	4.9	4.3	2.9	2.4	4.7
8..........	4.7	6.5	8.8	5.4	28.2	20.7	3.5	5.0	3.5	3.1	2.4	4.5
9..........	4.0	6.1	8.8	5.1	18.0	19.1	3.4	4.1	3.2	2.9	2.3	4.1
10..........	3.8	6.2	9.4	5.1	12.8	15.2	3.6	3.8	2.8	2.9	2.4	4.0
11..........	3.4	8.5	11.1	5.1	11.7	11.8	3.4	3.3	2.8	2.6	2.5	3.7
12..........	2.9	14.7	11.7	5.0	10.4	8.9	3.4	3.0	3.7	2.5	4.8	3.2
13..........	2.9	21.8	11.5	4.8	9.4	7.3	3.3	2.7	5.8	2.4	3.8	3.1
14..........	*	23.6	12.0	10.2	8.8	6.8	3.2	2.5	10.9	2.5	3.6	3.0
15..........	*	22.6	10.6	12.1	8.1	6.5	3.0	2.8	12.7	2.0	3.5	2.9
16..........	*	21.3	9.5	10.4	7.8	6.2	2.8	2.9	9.6	1.7	3.0	3.0
17..........	*	23.6	8.4	8.6	9.4	5.6	2.7	3.8	8.0	9.6	2.8	3.2
18..........	*	29.4	7.6	7.4	10.4	5.4	2.8	5.2	7.0	6.4	2.7	3.5
19..........	*	32.4	7.0	6.5	8.9	5.3	3.0	4.9	6.1	5.7	2.5	3.8
20..........	*	33.4	6.7	6.4	7.7	5.2	3.2	4.0	5.1	5.2	2.6	3.9
21..........	*	32.	6.3	7.2	7.4	5.4	3.5	2.9	4.2	4.1	2.6	3.9
22..........	*	28.5	6.0	7.2	6.7	5.6	3.6	2.6	3.6	3.4	2.6	3.5
23..........	2.9	18.2	5.8	7.1	6.1	5.7	4.6	2.4	3.4	3.1	2.5	3.3
24..........	3.1	12.3	5.7	6.8	5.7	5.4	5.2	2.3	3.2	2.8	2.5	3.1
25..........	3.1	10.4	6.4	6.7	5.4	5.9	5.5	2.2	3.0	3.1	2.4	2.9
26..........	3.4	9.3	6.8	6.0	5.2	5.6	3.7	1.9	2.9	3.3	2.5	2.8
27..........	3.7	8.4	6.8	5.7	5.0	5.2	3.4	1.8	2.7	4.9	2.6	2.7
28..........	3.8	8.2	6.3	7.0	4.6	5.1	2.9	1.6	2.6	4.6	2.8	2.5
29..........	4.4	......	5.9	9.5	5.4	4.7	3.7	1.6	2.4	4.0	2.7	2.5
30..........	5.3	......	5.8	10.4	6.5	4.1	2.6	1.7	2.5	3.5	2.5	2.7
31..........	7.1	......	5.7	......	7.4	....	2.6	1.6	......	3.2	......	3.1

*Frozen at gage.

Daily gage height of Tennessee River at Chattanooga, Tenn., for 1894.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.
1..........	2.9	5.1	7.7	5.0	3.9	3.8	4.4	2.9	4.0	0.9	1.4	1.0
2..........	3.4	5.0	8.2	4.8	3.8	3.6	4.0	2.9	3.8	.9	1.7	1.0
3..........	3.8	4.9	9.4	5.4	3.7	3.5	3.7	2.9	3.0	1.0	2.3	.9
4..........	3.9	5.5	9.7	5.3	3.7	3.4	4.4	2.8	2.6	1.5	1.6	.9
5..........	3.5	21.9	9.5	6.8	3.6	3.3	4.2	2.9	2.1	1.8	1.4	.9
6..........	3.1	25.5	9.3	6.9	3.5	3.2	3.7	3.0	2.0	1.8	1.5	.9
7..........	4.9	23.9	8.5	7.2	3.4	2.9	3.2	2.9	1.8	1.5	1.5	.9
8..........	6.1	19.7	8.2	7.4	3.3	2.8	3.3	2.9	1.7	1.3	1.3	.9
9..........	9.3	16.1	7.9	6.6	3.4	2.6	3.1	3.0	1.5	1.1	1.2	1.1
10..........	9.0	16.0	7.2	5.7	3.3	2.5	3.3	2.6	1.4	1.0	1.1	1.2
11..........	8.5	16.7	6.9	5.9	3.2	2.5	3.7	2.3	1.4	.8	1.0	1.6
12..........	7.9	15.4	6.6	7.2	4.7	2.4	3.3	2.1	1.4	.9	1.0	3.8
13..........	8.3	15.2	6.7	8.5	5.1	2.3	2.7	1.9	1.3	1.2	.9	8.6
14..........	8.0	14.1	7.2	7.8	4.8	2.3	2.4	1.8	1.2	1.9	.8	11.1
15..........	7.8	12.2	7.0	7.2	4.3	2.2	2.1	2.0	1.5	2.4	.8	11.2
16..........	7.8	10.3	6.9	6.9	4.0	2.1	1.9	3.6	1.8	2.1	.8	10.8
17..........	7.1	9.5	6.8	6.3	4.1	2.0	1.8	4.6	1.8	1.7	.8	8.6
18..........	7.2	8.6	7.3	5.5	5.2	2.1	2.8	3.5	2.0	1.4	.7	6.6
19..........	6.3	8.4	7.4	5.0	5.0	2.4	2.4	3.0	2.0	1.1	.8	4.7
20..........	6.0	8.3	7.7	5.1	5.4	2.5	2.4	3.1	1.6	1.0	.9	4.2
21..........	5.3	8.5	7.1	4.9	5.6	2.7	3.3	3.6	1.5	.9	.9	3.6
22..........	5.0	8.7	8.8	4.8	6.2	2.5	3.7	3.7	1.5	.8	.9	3.2
23..........	5.0	8.8	8.7	4.7	6.8	2.3	3.8	4.0	1.8	.8	1.0	2.8
24..........	5.2	8.2	8.1	4.6	6.9	2.2	3.4	3.6	1.8	.8	1.0	2.7
25..........	5.3	7.9	7.7	4.5	7.1	2.2	4.0	3.0	1.6	.8	1.1	2.5
26..........	5.2	7.6	7.3	4.3	6.7	2.5	1.4	2.6	1.3	.8	1.2	2.4
27..........	5.4	7.7	7.0	4.2	6.0	2.6	3.9	2.2	1.1	.7	1.2	4.2
28..........	5.4	7.7	6.5	4.1	5.6	2.7	3.8	2.7	1.0	.7	1.1	6.9
29..........	5.1	......	5.9	4.0	5.1	2.9	3.6	2.4	.9	.7	1.1	8.4
30..........	5.0	......	5.7	4.0	4.7	4.3	3.3	2.7	.8	1.0	1.1	7.9
31..........	4.9	......	5.2	......	4.2	....	3.3	4.3	......	1.1	......	5.8

Daily gage height of Tennessee River at Chattanooga, Tenn., for 1895.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.
1..........	4.7	7.6	6.8	7.8	6.0	5.6	3.2	4.4	3.3	0.9	1.1	1.4
2..........	3.9	7.2	7.3	7.4	5.8	5.2	3.4	4.1	3.4	.8	1.2	1.5
3..........	3.3	7.3	12.1	6.8	5.5	4.8	3.8	3.8	3.2	.8	1.3	1.4
4..........	3.2	7.5	18.2	6.5	5.4	4.5	4.0	3.5	3.1	.8	1.6	1.4
5..........	3.1	7.6	19.9	6.3	5.7	4.2	4.5	3.4	2.9	.8	1.6	1.4
6..........	3.1	7.4	18.2	6.2	6.0	4.4	5.0	3.0	2.8	.8	1.3	1.6
7..........	3.3	6.9	13.4	6.0	6.5	4.6	5.0	3.2	2.8	.8	1.3	1.5
8..........	4.0	6.5	10.5	9.6	7.0	5.2	5.1	3.3	2.8	.9	1.2	1.4
9..........	10.9	6.4	9.2	10.7	8.2	5.1	5.5	3.3	2.5	.8	1.1	1.3
10..........	20.5	5.0	8.6	11.4	8.6	4.6	5.7	3.0	2.4	.9	1.2	1.3
11..........	28.5	4.0	8.1	13.0	9.0	4.2	5.1	3.0	2.3	1.0	1.3	1.4
12..........	32.1	3.3	7.5	12.5	8.8	3.8	4.4	2.9	2.4	1.0	1.7	1.5
13..........	31.2	4.2	7.8	10.4	8.9	3.6	3.8	3.2	2.5	1.0	2.1	1.8
14..........	28.3	*	8.0	8.8	9.5	3.5	3.4	2.9	2.4	1.0	2.4	1.9
15..........	19.5	4.3	8.7	7.9	9.0	3.4	3.2	2.8	2.3	.9	2.2	2.0
16..........	12.3	4.7	9.4	7.4	8.2	3.4	3.2	2.7	2.2	1.0	2.0	1.9
17..........	10.9	4.7	9.2	7.0	7.7	3.8	3.7	3.1	2.1	1.0	1.9	1.8
18..........	10.0	4.2	9.6	9.0	7.1	3.7	3.6	4.3	2.3	1.0	1.8	1.7
19..........	9.7	4.7	9.4	11.8	7.0	3.5	3.3	4.9	2.2	.9	1.7	1.6
20..........	9.1	4.6	8.9	11.8	7.2	3.2	3.0	5.7	2.0	.9	1.5	1.5
21..........	9.6	5.1	14.3	9.9	7.1	3.1	2.7	5.3	2.1	.8	1.3	1.6
22..........	10.2	5.6	20.6	8.6	6.7	3.2	2.7	6.1	1.9	.8	1.1	2.1
23..........	9.9	6.1	22.7	7.7	6.5	3.1	2.5	5.3	1.6	.7	1.3	3.3
24..........	9.1	6.7	22.0	7.1	5.8	3.0	2.4	4.8	1.4	.7	1.4	4.2
25..........	10.8	6.8	18.2	6.7	5.6	2.9	2.4	4.6	1.3	.7	1.3	4.6
26..........	10.8	6.5	13.0	6.3	5.6	2.9	2.9	4.7	1.3	.7	1.3	4.3
27..........	10.0	6.3	11.3	6.0	7.0	2.6	3.8	4.2	1.2	.7	1.3	4.2
28..........	9.3	6.3	10.6	6.0	7.5	2.5	10.2	3.7	1.1	.7	1.3	4.5
29..........	8.8	......	9.5	5.9	7.4	2.5	10.4	3.5	1.0	.7	1.3	5.2
30..........	8.6	......	8.9	5.9	6.7	2.6	7.4	3.7	0.9	.7	1.5	4.7
31..........	8.4	......	8.4	......	6.0	....	5.3	3.4	......	1.0	......	4.7

*Frozen.

Rating table for Tennessee River at Chattanooga, Tennessee.

[This table is applicable from Jan. 1, 1890, to Dec. 31, 1895.]

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second ft.*	*Feet.*	*Second ft.*	*Feet.*	*Second ft.*	*Feet.*	*Second ft.*
0.7	16,360	11.0	66,850	22.5	133,665	34.0	293,820
0.8	16,560	11.5	69,755	23.0	136,570	34.5	302,720
0.9	16,780	12.0	72,660	23.5	139,475	35.0	311,620
1.0	17,000	12.5	75,565	24.0	142,380	35.5	320,520
1.5	18,160	13.0	78,470	24.5	145,285	36.0	329,420
2.0	19,500	13.5	81,375	25.0	148,190	36.5	338,320
2.5	21,100	14.0	84,280	25.5	151,095	37.0	347,220
3.0	23,000	14.5	87,185	26.0	154,000	37.5	356,120
3.5	25,090	15.0	90,090	26.5	162,500	38.0	365,020
4.0	27,300	15.5	92,995	27.0	171,000	38.5	373,920
4.5	29,660	16.0	95,900	27.5	179,900	39.0	382,820
5.0	32,200	16.5	98,805	28.0	188,800	39.5	391,720
5.5	34,895	17.0	101,710	28.5	197,700	40.0	400,620
6.0	37,800	17.5	104,615	29.0	206,600	40.5	409,520
6.5	40,705	18.0	107,520	29.5	215,500	41.0	418,420
7.0	43,610	18.5	110,425	30.0	224,400	41.5	427,320
7.5	46,515	19.0	113,330	30.5	233,300	42.0	436,220
8.0	49,420	19.5	116,235	31.0	242,200	42.5	445,120
8.5	52,325	20.0	119,140	31.5	251,100	43.0	454,020
9.0	55,230	20.5	122,045	32.0	260,000	43.5	462,920
9.5	58,135	21.0	124,950	32.5	268,900	44.0	471,820
10.0	61,040	21.5	127,855	33.0	276,020	44.5	480,720
10.5	63,945	22.0	130,760	33.5	284,920		

NOTE—This table applied to the foregoing "daily gage heights" gives the cubic feet per second flowing in the river on each date for which the gage height is given.

Daily gage height of Tennessee River at Chattanooga, Tenn., for 1896.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.
1..........	4.9	4.4	4.1	14.8	3.4	2.6	3.3	5.5	2.4	2.5	1.2	2.4
2..........	5.0	6.2	3.9	27.7	3.4	3.0	3.2	5.2	2.1	2.3	1.2	2.5
3..........	4.9	10.0	3.8	34.4	3.4	4.4	3.1	4.8	1.9	2.6	1.3	2.5
4..........	4.9	11.6	3.7	38.8	3.5	5.7	3.2	4.6	1.8	3.0	1.5	2.6
5..........	4.7	10.5	3.6	40.5	4.0	5.2	3.3	4.5	1.6	2.7	1.5	2.6
6..........	4.3	9.3	3.5	36.9	4.6	4.7	3.2	4.9	1.6	2.6	1.6	2.7
7..........	3.6	11.8	3.4	23.3	4.6	4.1	3.6	5.0	1.5	2.1	2.3	2.9
8..........	3.3	14.0	3.5	11.6	4.3	3.5	5.0	4.2	2.0	1.7	3.5	3.0
9..........	3.2	13.8	3.5	9.0	4.0	3.5	3.9	3.8	2.8	1.5	4.2	2.8
10..........	3.2	13.2	3.4	8.0	3.7	4.5	14.2	3.4	2.7	1.4	4.1	2.8
11..........	3.1	12.8	3.6	7.2	3.4	7.0	21.1	3.3	2.4	1.2	3.3	2.7
12..........	3.1	11.4	3.6	6.7	3.1	6.3	21.6	3.4	2.0	1.2	3.2	2.6
13..........	2.9	10.1	3.8	6.2	2.9	5.1	15.6	3.2	1.8	1.2	5.8	2.4
14..........	2.7	11.1	3.8	5.8	2.8	4.3	11.5	3.2	1.6	1.2	7.3	2.6
15..........	2.6	12.8	3.7	5.5	2.7	3.6	11.2	3.1	1.6	1.5	6.5	4.1
16..........	2.4	13.6	3.8	5.2	2.6	3.2	11.4	3.0	1.5	1.7	5.5	6.5
17..........	2.3	12.5	5.5	5.0	2.5	3.0	11.0	3.0	1.3	1.6	4.9	6.6
18.....	2.3	11.0	10.1	4.8	2.4	2.8	13.9	2.9	1.4	1.6	4.3	6.3
19..........	2.3	9.0	13.1	4.2	2.4	2.9	12.5	2.7	1.4	1.7	3.8	6.4
20..........	2.3	7.6	15.7	4.4	2.2	3.1	9.6	2.6	1.3	1.6	3.4	6.8
21..........	2.3	6.7	13.8	4.2	2.1	3.7	7.6	2.4	1.2	1.6	3.0	7.0
22..........	2.5	6.0	11.2	4.1	2.1	3.5	6.5	2.4	1.2	1.4	2.8	7.2
23..........	3.1	5.4	9.5	4.1	2.5	3.5	8.5	2.2	1.3	1.2	2.5	7.3
24..........	5.0	4.9	8.4	4.0	3.2	3.3	8.8	2.2	1.4	1.2	2.4	7.0
25..........	6.5	4.7	7.9	4.0	3.6	3.1	8.6	2.8	1.6	1.2	2.3	6.6
26..........	8.2	4.6	7.5	3.8	3.8	2.9	7.8	2.6	2.0	1.2	2.2	5.9
27..........	8.0	4.5	7.2	3.8	3.2	2.6	11.1	2.7	1.7	1.2	2.1	5.3
28..........	7.0	4.4	6.7	3.8	3.1	2.6	12.2	3.2	1.5	1.2	2.2	4.8
29..........	6.0	4.2	6.2	3.6	2.8	2.8	9.3	4.0	1.5	1.1	5.3	4.4
30..........	5.3	......	5.8	3.6	2.7	3.0	7.2	3.6	2.7	1.1	9.4	3.7
31..........	4.8	......	7.7	......	2.5	....	6.2	2.8	......	1.3	......	3.0

The following discharge measurements were made by Max Hall and others during 1897:

May 8—Gage height, 7.07 feet; discharge, 44,187 second-feet.
May 28—Gage height, 4.52 feet; discharge, 25,892 second-feet.
June 29—Gage height, 5.76 feet; discharge, 32,943 second-feet.
July 13—Gage height, 4.59 feet; discharge, 26,884 second-feet.
Sept. 7—Gage height, 1.67 feet; discharge, 10,313 second-feet.
Oct. 6—Gage height, 0.48 feet; discharge, 5,969 second-feet.
Nov. 16—Gage height, 0.83 feet; discharge, 5,552 second-feet.
Dec. 23—Gage height, 10.30 feet; discharge, 67,000 second-feet.

Daily gage height of Tennessee River at Chattanooga, Tenn., for 1897.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec
1..........	2.4	3.0	12.5	8.7	5.9	4.3	5.0	4.4	2.1	0.8	0.8	1.0
2..........	2.5	7.0	9.6	12.2	6.3	4.2	4.0	3.9	2.2	.8	.9	1.2
3..........	2.8	10.1	8.6	15.0	7.4	4.1	3.8	3.8	1.9	.7	1.0	1.3
4..........	2.6	10.5	9.0	16.0	9.6	4.1	3.4	3.6	1.8	.6	1.2	2.0
5..........	2.6	9.4	9.5	26.0	9.6	4.1	3.4	3.3	1.8	.5	1.2	3.3
6..........	2.7	8.3	12.1	30.4	8.5	4.1	4.0	3.5	1.7	.5	1.3	3.8
7..........	2.9	8.8	19.2	29.7	7.7	4.4	3.8	4.4	1.7	.5	1.4	3.9
8..........	3.0	10.7	25.1	25.4	7.2	4.4	3.8	4.2	1.6	.4	1.2	3.5
9..........	2.8	14.1	24.2	20.0	6.6	4.0	4.4	4.2	1.6	.4	1.2	2.9
10..........	2.8	15.5	21.3	16.0	6.2	5.2	4.0	5.6	1.4	.4	1.2	2.6
11..........	2.7	13.2	22.3	14.0	6.0	5.0	4.1	5.2	1.3	.5	1.1	2.4
12..........	2.6	10.8	28.4	26.0	6.2	5.7	4.5	4.6	1.2	.6	1.0	2.1
13..........	2.4	9.9	34.9	11.4	7.8	5.0	4.6	4.1	1.2	.9	1.0	1.8
14..........	2.6	10.0	37.9	10.3	18.4	4.3	4.2	3.5	1.1	1.4	.9	1.8
15..........	4.1	10.5	37.9	9.7	22.4	3.9	3.8	3.1	1.0	1.1	.8	2.5
16..........	6.5	10.7	37.0	9.8	20.3	3.6	3.6	2.8	1.0	1.2	.8	2.7
17..........	6.6	9.8	36.0	10.2	16.5	3.7	4.5	2.6	.9	1.2	.8	2.5
18..........	6.3	8.6	33.8	9.9	11.9	3.6	6.3	3.0	.9	1.2	.8	2.5
19..........	.64	7.6	29.6	9.3	9.1	3.3	6.1	3.4	.8	1.1	.8	2.6
20..........	6.8	7.0	29.6	8.8	7.7	3.5	5.6	3.0	.8	1.4	.7	3.4
21..........	7.0	7.0	32.4	8.1	6.9	4.1	6.7	3.0	.9	2.0	.7	4.5
22..........	7.2	8.3	33.3	7.5	6.4	5.0	6.1	3.4	.9	1.9	.7	7.1
23..........	7.3	13.2	30.9	7.0	5.9	4.8	5.8	3.1	.8	1.6	.7	10.2
24..........	7.0	25.2	25.0	6.7	5.6	5.3	6.0	3.8	.9	1.4	.7	9.3
25..........	6.6	31.6	18.1	6.4	5.3	5.5	8.4	3.4	.8	1.6	.7	7.7
26..........	5.9	34.8	14.2	6.2	5.1	6.2	9.7	2.9	.8	1.4	.7	6.4
27..........	5.3	33.8	12.2	6.0	4.8	5.4	13.5	2.8	.7	1.2	.7	5.6
28..........	4.8	23.6	10.8	6.1	4.6	5.5	8.7	2.8	.7	1.0	.7	5.0
29..........	4.4	......	9.8	6.2	4.4	6.2	6.7	2.5	.7	.9	.7	4.5
30..........	3.7	......	9.1	5.8	4.2	5.2	5.6	2.2	.8	.8	.9	4.0
31..........	3.0	......	8.6	......	4.2	....	5.0	2.1	......	.8	......	3.8

Rating table for Tennessee River at Chattanooga, Tennessee, for (a) 1896-1897.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Fee .	Second ft.	Fee	Second ft.	Feet	Second ft	Feet.	Second ft.
0.2	3,080	1.4	10,208	3.4	22,088	12.0	73,172
0.3	3,674	1.6	11,396	3.6	23,276	13.0	79,112
0.4	4,268	1.8	12,584	3.8	24,464	14.0	85,052
0.5	4,862	2.0	13,772	4.0	25,652	15.0	90,992
0.6	5,456	2.2	14,960	4.4	28,028	16.0	96,932
0.7	6,050	2.4	16,148	4.8	30,404	18.0	108,812
0.8	6,644	2.6	17,336	6.0	37,532	20.0	120,690
0.9	7,238	2.8	18,524	8.0	49,412	22.0	132,570
1.0	7,832	3.0	19,712	10.0	61,292	24.0	144,450
1.2	9,020	3.2	20,900	11.0	67,232	26.0	156,330

a Above 26 feet use table as published in the Eighteenth Ann. Rept., Part IV, p. 120.

NOTE—This table applied to the foregoing "daily gage heights" gives the cubic feet per second flowing in the river on each date for which the gage height is given.

The following discharge measurements were made on the Tennessee River at Chattanooga, Tenn., by Max Hall and others during 1898:

May 10—Gage height, 4.14 feet; discharge, 22,066 second-feet.
July 29—Gage height, 5.30 feet; discharge, 29,693 second-feet.
August 19—Gage height, 6.37 feet; discharge, 36,671 second-feet.
Oct. 6—Gage height, 17.60 feet; discharge, 120,359 second-feet.
Oct. 28—Gage height, 6.00 feet; discharge, 35,953 second-feet.
Nov. 29—Gage height, 4.75 feet; discharge, 29,569 second-feet.
Nov. 29—Gage height, 4.70 feet; discharge, 31,340 second-feet.

Daily gage height, in feet, of Tennessee River at Chattanooga, Tenn., for 1898.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec
1..........	3.45	7.55	3.30	17.45	6.40	3.35	2.45	8.15	3.55	3.55	4.60	5.10
2..........	3.25	6.70	3.15	17.80	5.80	3.30	2.35	7.55	3.95	3.30	4.30	5.05
3..........	3.05	6.15	3.00	15.00	5.40	3.30	2.25	6.45	9.15	3.20	4.25	4.90
4..........	2.90	5.40	2.95	11.45	5.05	3.30	2.05	5.35	18.50	3.90	4.05	5.00
5..........	2.75	5.00	3.30	10.35	4.70	2.85	2.35	6.25	25.00	8.90	3.90	5.05
6..........	2.65	4.55	3.45	12.15	4.45	2.55	2.10	11.85	22.15	16.90	3.90	5.60
7..........	2.70	4.45	3.50	11.60	4.35	2.35	2.10	14.65	15.70	16.50	4.25	5.95
8..........	2.80	4.35	3.40	10.30	4.10	2.20	2.15	12.55	11.25	10.75	4.45	5.90
9..........	3.05	4.30	3.25	9.30	4.20	2.05	2.60	10.15	9.50	8.80	4.60	5.85
10..........	3.25	4.15	3.05	8.30	4.15	1.95	3.05	8.50	8.60	8.40	4.45	5.55
11..........	3.25	4.00	2.90	8.60	4.45	1.30	3.50	9.05	7.45	7.55	4.65	5.10
12..........	5.50	3.90	2.85	9.60	4.65	1.95	3.40	12.30	6.45	6.55	5.05	4.75
13..........	13.20	3.80	2.80	9.40	4.40	1.80	3.20	14.85	5.70	6.00	5.30	4.55
14..........	14.40	3.80	2.85	9.00	4.25	1.75	2.80	15.85	5.20	5.70	4.95	4.20
15..........	12.25	3.80	3.15	9.05	3.95	1.65	2.85	14.95	4.80	5.35	4.55	4.00
16..........	12.20	3.70	5.10	9.15	3.90	1.75	3.50	11.60	4.45	4.90	4.40	3.85
17..........	12.35	3.55	5.05	8.60	3.80	2.00	4.55	8.90	4.25	4.70	4.55	3.70
18..........	10.00	3.50	5.20	8.20	3.70	2.35	5.35	7.10	3.95	5.25	4.75	3.60
19..........	9.20	3.30	5.50	8.00	3.70	3.50	4.60	6.40	3.75	6.70	4.95	3.75
20..........	11.70	3.30	6.10	7.95	3.65	4.05	4.15	6.05	3.55	7.75	5.30	5.20
21..........	13.80	3.20	5.70	7.40	3.60	5.35	4.00	5.95	3.45	9.30	5.85	5.85
22..........	13.40	3.25	5.45	7.05	3.60	5.55	3.30	5.65	3.55	8.80	6.05	6.00
23..........	12.55	3.40	5.15	6.60	3.50	5.05	3.30	5.40	5.00	7.65	6.55	5.85
24..........	12.35	3.50	4.65	6.85	3.40	4.55	3.40	4.75	5.05	7.25	6.85	5.35
25..........	13.35	3.60	4.30	6.65	3.45	3.70	3.55	4.30	6.40	7.20	6.55	5.20
26..........	16.05	3.80	4.15	6.30	3.70	3.40	3.55	4.05	7.20	7.60	6.10	5.40
27..........	18.20	3.50	4.45	6.45	4.95	2.90	4.55	4.00	6.15	6.90	5.65	5.90
28..........	16.70	3.35	4.45	7.10	5.60	2.80	5.55	4.10	5.00	6.20	5.15	5.70
29..........	14.15	......	4.65	7.05	4.90	2.80	5.35	[illegible]	4.30	5.65	4.80	5.15
30..........	11.20	......	5.55	6.75	4.20	2.55	5.90	4.10	3.85	5.15	4.95	4.80
31..........	8.95	......	13.25	......	3.70	....	7.90	3.85	......	4.85	......	4.50

Rating table for Tennessee River at Chattanooga, Tenn., for 1898.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second ft.*	*Feet.*	*Second feet.*	*Feet.*	*Second feet.*	*Feet.*	*Second feet.*
0.5	5,900	3.7	19,550	6.9	42,370	10.5	68,650
0.6	6,266	3.8	20,120	7.0	43,100	11.0	72,300
0.7	6,634	3.9	20,700	7.1	43,830	11.5	75,950
0.8	7,004	4.0	21,320	7.2	44,560	12.0	79,600
0.9	7,376	4.1	21,950	7.3	45,290	12.5	83,250
1.0	7,750	4.2	22,580	7.4	46,020	13.0	86,900
1.1	8,126	4.3	23,350	7.5	46,750	13.5	90,550
1.2	8,504	4.4	24,120	7.6	47,480	14.0	94,200
1.3	8,884	4.5	24,850	7.7	48,210	14.5	97,850
1.4	9,266	4.6	25,580	7.8	48,940	15.0	101,500
1.5	9,650	4.7	26,310	7.9	49,670	15.5	105,150
1.6	10,046	4.8	27,040	8.0	50,400	16.0	108,800
1.7	10,444	4.9	27,770	8.1	51,130	16.5	112,450
1.8	10,844	5.0	28,500	8.2	51,860	17.0	116,100
1.9	11,246	5.1	29,230	8.3	52,590	17.5	119,750
2.0	11,650	5.2	29,960	8.4	53,320	18.0	123,400
2.1	12,056	5.3	30,690	8.5	54,050	18.5	127,050
2.2	12,464	5.4	31,420	8.6	54,780	19.0	130,700
2.3	12,874	5.5	32,150	8.7	55,510	19.5	134,350
2.4	13,286	5.6	32,880	8.8	56,240	20.0	138,000
2.5	13,700	5.7	33,610	8.9	56,970	20.5	141,650
2.6	14,126	5.8	34,340	9.0	57,700	21.0	145,300
2.7	14,562	5.9	35,070	9.1	58,430	21.5	148,950
2.8	15,008	6.0	35,800	9.2	59,160	22.0	152,600
2.9	15,464	6.1	36,530	9.3	59,890	22.5	156,250
3.0	15,930	6.2	37,260	9.4	60,620	23.0	159,900
3.1	16,410	6.3	37,990	9.5	61,350	23.5	163,550
3.2	16,900	6.4	38,720	9.6	62,080	24.0	167,200
3.3	17,400	6.5	39,450	9.7	62,810	24.6	171,680
3.4	17,920	6.6	40,180	9.8	63,540		
3.5	18,460	6.7	40,910	9.9	64,270		
3.6	19,000	6.8	41,640	10.0	65,000		

NOTE—This table applied to the foregoing "daily gage heights" gives the cubic feet per second flowing in the river on each date for which the gage height is given.

The following measurements were made by Max Hall and others during 1899:

May 3—Gage height, 6.71 feet; discharge, 37,770 second-feet.
May 26—Gage height, 4.76 feet; discharge, 25,526 second-feet.
June 21—Gage height, 4.15 feet; discharge, 21.391 second-feet.
Sept. 15—Gage height, 1.90 feet; discharge, 10,819 second-feet.
Oct. 27—Gage height, 0.80 foot; discharge, 6,566 second-feet.

Daily gage height in feet of Tennessee River at Chattanooga, Tenn., for 1899.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.
1..........	4.75	5.70	19.25	22.80	7.60	4.15	3.45	4.20	2.20	1.20	1.10	1.70
2..........	4.95	5.65	17.60	19.50	7.10	4.25	3.30	3.55	2.35	1.10	1.10	1.70
3..........	5.30	5.60	15.15	14.90	6.70	4.40	3.05	3.05	2.80	1.05	1.05	1.70
4..........	5.80	10.70	14.15	12.95	6.30	4.85	2.80	2.75	3.05	.95	1.10	1.70
5..........	5.95	23.10	17.95	13.25	6.15	4.65	2.60	2.45	2.65	.90	1.50	1.80
6..........	7.25	30.45	24.50	14.70	7.10	4.25	2.60	2.45	2.25	.80	1.50	1.70
7..........	18.80	34.30	26.55	15.70	8.50	4.05	2.65	2.40	1.95	.85	1.50	1.60
8..........	18.40	36.95	27.60	18.05	9.35	3.75	3.05	2.40	1.80	1.00	1.45	1.50
9..........	17.35	38.25	27.70	17.75	10.05	3.55	2.90	2.25	1.60	1.15	1.35	1.40
10..........	17.15	36.75	16.15	15.70	10.70	3.40	2.60	2.10	1.80	1.60	1.20	1.40
11..........	13.85	30.30	11.85	14.20	11.15	3.90	2.55	2.10	1.70	1.80	1.15	1.60
12..........	10.50	19.35	10.60	12.90	10.40	4.30	2.45	2.00	2.00	1.85	1.10	5.20
13..........	9.15	12.15	9.55	11.65	9.60	5.25	2.30	2.00	1.80	1.70	1.00	6.45
14..........	8.10	9.50	11.20	10.70	9.30	5.80	2.20	2.25	2.00	1.65	1.00	7.40
15..........	7.55	8.50	24.55	10.00	9.55	6.45	2.15	2.65	1.85	1.40	1.00	7.15
16..........	7.30	7.55	34.25	9.40	9.20	6.10	1.95	2.65	1.65	1.25	1.00	6.20
17..........	7.40	7.95	36.90	8.75	8.70	6.40	1.90	2.40	1.45	1.15	1.00	5.20
18..........	7.45	9.55	36.15	8.40	7.75	6.20	1.80	2.30	1.35	1.15	1.00	4.25
19..........	7.25	11.30	35.85	8.00	6.90	5.25	1.90	2.15	1.20	1.10	1.00	3.85
20..........	7.00	12.65	37.05	7.55	6.40	4.70	2.05	1.90	1.05	1.10	.95	4.25
21..........	6.80	11.50	39.20	7.35	5.90	4.20	2.05	1.70	1.00	1.10	.85	4.40
22..........	6.45	10.65	40.00	7.05	5.60	3.75	2.40	1.60	1.05	1.10	.85	4.40
23..........	5.90	10.10	38.70	7.85	5.35	3.50	2.70	1.45	1.30	1.05	1.00	4.15
24..........	5.65	9.75	32.70	9.65	5.30	3.25	3.50	1.30	1.50	1.00	1.15	5.65
25..........	6.05	9.50	23.15	9.35	5.05	3.15	3.40	1.20	1.50	.95	1.20	6.15
26..........	6.35	9.20	16.30	10.75	4.80	3.00	3.00	1.20	1.45	.85	1.70	6.30
27..........	5.85	13.20	13.65	10.30	4.65	3.25	3.05	1.20	1.30	.80	1.80	5.85
28..........	5.75	18.45	13.95	9.20	4.40	3.65	3.65	1.25	1.20	.80	1.85	5.55
29..........	5.55	......	17.30	8.35	4.30	3.50	4.25	1.50	1.25	.90	1.80	5.10
30..........	5.30	......	21.20	7.75	4.20	3.30	4.25	1.85	1.30	1.00	1.75	4.65
31..........	5.30	......	22.80	......	4.25	....	5.15	1.75	......	1.05	......	3.85

During 1900 the following measurements were made by Max Hall and others:

March 13—Gage height, 11.25 feet; discharge, 66,012 secod-feet.
July 27—Gage height, 3.45 feet; discharge, 18,470 second-feet.

Daily gage height in feet of Tennessee River at Chattanooga, Tenn., for 1900.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec
1..........	3.05	3.25	8.05	7.85	6.20	2.85	8.85	6.20	2.10	2.00	2.90	8.70
2..........	*	2.95	8.70	7.20	5.65	2.80	8.15	5.40	2.00	1.80	2.60	6.50
3..........	*	2.60	10.90	6.85	5.35	3.00	6.95	4.70	2.30	1.70	2.50	5.60
4..........	*	2.50	12.50	7.25	5.15	3.20	6.30	4.20	2.50	1.50	2.90	5.10
5..........	*	2.90	12.75	8.05	4.95	3.20	5.80	3.60	2.30	1.40	3.30	5.60
6..........	2.10	3.50	10.65	8.55	4.80	3.50	5.40	3.20	2.00	1.30	3.70	6.90
7..........	2.20	3.95	10.00	7.85	4.65	5.65	5.00	2.90	1.70	1.30	4.20	8.30
8..........	2.30	3.90	11.65	7.05	4.45	6.65	4.50	2.60	1.60	1.60	4.20	9.20
9..........	2.35	5.35	14.55	6.50	4.45	6.15	4.2	2.40	1.40	1.80	3.70	8.50
10..........	2.45	8.40	16.50	6.10	4.35	5.30	4.20	2.30	1.30	2.10	3.20	7.00
11..........	3.35	9.40	16.15	6.50	4.30	5.00	4.30	2.10	1.20	2.10	3.00	6.10
12..........	6.05	8.95	14.25	7.50	4.30	4.90	3.80	2.00	1.10	2.50	2.70	5.40
13..........	8.15	13.90	11.65	7.40	4.15	4.50	3.40	1.90	1.00	3.00	2.50	4.90
14..........	8.70	21.55	9.85	7.00	4.00	5.20	3.30	1.90	1.10	2.50	2.30	4.50
15..........	8.45	24.00	8.65	6.50	3.85	5.30	3.30	2.10	1.80	1.90	2.20	4.30
16..........	7.80	21.40	8.00	6.30	3.75	5.25	3.30	2.20	3.10	1.80	2.10	4.20
17..........	6.35	17.00	7.80	8.75	3.60	5.45	3.20	2.30	4.00	1.60	2.00	4.00
18..........	5.50	12.05	7.55	10.65	3.50	6.15	3.10	2.30	4.10	1.50	2.00	3.60
19..........	5.80	9.25	7.55	9.75	3.40	8.85	3.00	2.30	4.60	1.40	1.90	3.40
20..........	8.50	7.70	8.55	9.40	3.40	9.20	2.90	2.20	4.70	1.30	1.90	3.30
21..........	9.40	7.10	11.60	11.70	3.25	8.90	2.70	1.90	3.90	1.20	2.10	3.30
22..........	8.85	7.70	14.95	12.00	3.15	7.65	2.50	1.80	3.00	1.20	2.20	4.00
23..........	7.95	8.50	17.40	11.35	3.05	6.40	2.50	1.70	2.60	1.40	2.30	4.20
24..........	7.20	8.55	16.45	10.70	3.00	6.25	2.80	1.80	2.40	2.20	2.80	4.70
25..........	6.15	8.50	12.65	9.75	3.15	7.15	3.00	1.90	2.70	4.10	3.20	5.20
26..........	5.50	9.50	11.15	8.50	3.20	7.60	3.10	2.50	2.70	7.00	7.80	5.40
27..........	5.00	9.30	10.90	7.80	3.35	8.05	3.30	3.10	2.60	7.50	13.90	5.20
28..........	4.65	8.45	10.70	7.45	3.60	8.20	4.60	2.70	2.40	6.00	15.60	4.60
29..........	4.20	......	10.20	7.05	3.60	8.60	8.00	2.50	2.30	4.90	15.60	4.30
30..........	3.90	......	9.35	6.60	3.35	8.70	8.20	2.30	2.20	3.70	13.20	[illegible]
31..........	3.55	......	8.50	......	3.05	....	7.30	2.20	......	3.40	......	4.50

*Frozen at gage.

Rating table for Tennessee River at Chattanooga, Tennessee, for 1899-1900.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second ft.*	*Feet.*	*Second ft.*	*Feet.*	*Second ft*	*Feet.*	*Second ft.*
0.8	6,600	10.7	62,340	20.6	123,720	30.5	185,100
0.9	6,950	10.8	62,960	20.7	124,340	30.6	185,720
1.0	7,300	10.9	63,580	20.8	124,960	30.7	186,340
1.1	7,670	11.0	64,200	20.9	125,580	30.8	186,960
1.2	8,040	11.1	64,820	21.0	126,200	30.9	187,580
1.3	8,430	11.2	65,440	21.1	126,820	31.0	188,200
1.4	8,820	11.3	66,060	21.2	127,440	31.1	188,820
1.5	9,220	11.4	66,680	21.3	128,060	31.2	189,440
1.6	9,620	11.5	67,300	21.4	128,680	31.3	190,060
1.7	10,020	11.6	67,920	21.5	129,300	31.4	190,680
1.8	10,430	11.7	68,540	21.6	129,920	31.5	191,300
1.9	10,840	11.8	69,160	21.7	130,540	31.6	191,920
2.0	11,250	11.9	69,780	21.8	131,160	31.7	192,540
2.1	11,660	12.0	70,400	21.9	131,780	31.8	193,160
2.2	12,080	12.1	71,020	22.0	132,400	21.9	193,780
2.3	12,500	12.2	71,640	22.1	133,020	32.0	194,400
2.4	12,930	12.3	72,260	22.2	133,640	32.1	195,020
2.5	13,360	12.4	72,880	22.3	134,260	32.2	195,640
2.6	13,800	12.5	73,500	22.4	134,880	32.3	196,260
2.7	14,240	12.6	74,120	22.5	135,500	32.4	196,880
2.8	14,680	12.7	74,740	22.6	136,120	32.5	197,500
2.9	15,140	12.8	75,360	22.7	136,740	32.6	198,120
3.0	15,600	12.9	75,980	22.8	137,360	32.7	198,740
3.1	16,080	13.0	76,600	22.9	137,980	32.8	199,360
3.2	16,550	13.1	77,220	23.0	138,600	32.9	199,980
3.3	17,050	13.2	77,840	23.1	139,220	33.0	200,600
3.4	17,550	13.3	78,460	23.2	139,840	33.1	201,220
3.5	18,050	13.4	79,080	23.3	140,460	33.2	201,840
3.6	18,550	13.5	79,700	23.4	141,080	33.3	202,460
3.7	19,050	13.6	80,320	23.5	141,700	33.4	203,080
3.8	19,600	13.7	80,940	23.6	142,320	33.5	203,700
3.9	20,200	13.8	81,560	23.7	142,940	33.6	204,320
4.0	20,800	13.9	82,180	23.8	143,560	33.7	204,940
4.1	21,420	14.0	82,800	23.9	144,180	33.8	205,560
4.2	22,040	14.1	83,420	24.0	144,800	33.9	206,180
4.3	22,660	14.2	84,040	24.1	145,420	34.0	206,800
4.4	23,280	14.3	84,660	24.2	146,040	34.1	207,420
4.5	23,900	14.4	85,280	24.3	146,660	34.2	208,040
4.6	24,520	14.5	85,900	24.4	147,280	34.3	208,660
4.7	25,140	14.6	86,520	24.5	147,900	34.4	209,280
4.8	25,760	14.7	87,140	24.6	148,520	34.5	209,900
4.9	26,380	14.8	87,760	24.7	149,140	34.6	210,520
5.0	27,000	14.9	88,380	24.8	149,760	34.7	211,140
5.1	27,620	15.0	89,000	24.9	150,380	34.8	211,760
5.2	28,240	15.1	89,620	25.0	151,000	34.9	212,380
5.3	28,860	15.2	90,240	25.1	151,620	35.0	213,000
5.4	29,480	15.3	90,860	25.2	152,240	35.1	213,620
5.5	30,100	15.4	91,480	25.3	152,860	35.2	214,240
5.6	30,720	15.5	92,100	25.4	153,480	35.3	214,860

Rating table for Tennessee River at Chattanooga, Tennessee, for 1899-1900.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second ft.*	*Feet.*	*Second ft.*	*Feet,*	*Second ft.*	*Feet.*	*Second ft.*
5.7	31,340	15.6	92,720	25.5	154,100	35.4	215,480
5.8	31,960	15.7	93,340	25.6	154,720	35.5	216,100
5.9	32,580	15.8	93,960	25.7	155,340	35.6	216,720
6.0	33,200	15.9	94,580	25.8	155,960	35.7	207,340
6.1	33,820	16.0	95,200	25.9	156,580	35.8	217,960
6.2	34,440	16.1	95,820	26.0	157,200	35.9	218,580
6.3	35,060	16.2	96,440	26.1	159,820	36.0	219,200
6.4	35.680	16.3	97,060	26.2	158,440	36.1	219,820
6.5	36,300	16.4	97,680	26.3	159,060	36.2	220,440
6.6	36,920	16.5	98,300	26.4	159,680	36.3	221,060
6.7	37,540	16.6	98,920	26.5	160,300	36.4	221,680
6.8	38,160	16.7	99,540	26.6	160,920	36.5	222,300
6.9	38,780	16.8	100,160	26.7	161,540	36.6	222,920
7.0	39,400	16.9	100,780	26.8	162,160	36.7	223,540
7.1	40,020	17.0	101,400	26.9	162,780	36.8	224,160
7.2	40,640	17.1	102,020	27.0	163,400	36.9	224,780
7.3	41,260	17.2	102,640	27.1	164,020	37.0	225,400
7.4	41,380	17.3	103,260	27.2	164,640	37.1	226,020
7.5	42,500	17.4	103,880	27.3	165,260	37.2	226,640
7.6	43,120	17.5	104,500	27.4	165,880	37.3	227,260
7.7	43,740	17.6	105,120	27.5	166,500	37.4	227,880
7.8	44,360	17.7	105,740	27.6	167,120	37.5	228,500
7.9	44,980	17.8	106,360	27.7	167,740	37.6	229,120
8.0	45,600	17.9	106,980	27.8	168,360	37.7	229,740
8.1	46,220	18.0	107,600	27.9	168,980	37.8	230,360
8.2	46,840	18.1	108,220	28.0	169,600	37.9	230,980
8.3	47,460	18.2	108,840	28.1	170,220	18.0	231,600
8.4	48,080	18.3	109,460	28.2	170,840	38.1	232,220
8.5	48,700	18.4	110,080	28.3	171,460	38.2	232,840
8.6	49,320	18.5	110,700	28.4	172,080	38.3	233,460
8.7	49,940	18.6	111,320	28.5	172,700	38.4	234,080
8.8	50,560	18.7	111,940	28.6	173,320	38.5	234,700
8.9	51,180	18.8	112,560	28.7	173,940	38.6	235,320
9.0	51,800	18.9	113,180	28.8	174,560	38.7	235,940
9.1	52,420	19.0	113,800	28.9	175,180	38.8	236,560
9.2	53,040	19.1	114,420	29.0	175,800	38.9	237,180
9.3	53,660	19.2	115,040	29.1	176,420	39.0	237,800
9.4	54,280	19.3	115,660	29.2	177,040	39.1	238,420
9.5	54,900	19.4	116,280	29.3	177,660	39.2	239,040
9.6	55,520	19.5	116,900	29.4	178,280	39.3	239,660
9.7	56,140	19.6	117,520	29.5	178,900	39.4	240,280
9.8	56,760	19.7	118,140	29.6	179,520	39.5	240,900
9.9	57,380	19.8	118,760	29.7	180,140	39.6	241,520
10.0	58,000	19.9	119,380	29.8	180,760	39.7	242,140
10.1	58,620	20.0	120,000	29.9	181,380	39.8	242,760
10.2	59,240	20.1	120,620	30.0	182,000	39.9	243,380
10.3	59,860	20.2	121,240	30.1	182,620	40.0	244,000

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second ft.*	*Feet.*	*Second ft.*	*Feet.*	*Second ft.*	*Feet.*	*Second ft.*
10.4	60,480	20.3	121,860	30.2	183,240		
10.5	61,100	20.4	122,480	30.3	183,860		
10.6	61,720	20.5	123,100	30.4	184,480		

Note—This table applied to the foregoing "daily gage heights" gives the cubic feet per second flowing in the river on each date for which the gage height is given.

The following discharge measurements were made on the Tennessee River at Chattanooga, Tenn., during 1901:

1901.

Jan. 24—Hydrographer, Max Hall: Gage height, 5.60 feet; discharge, 30,317 second-feet.

April 4—Hydrographer, K. T. Thomas: Gage height, 24.20 feet; discharge, 155,457 second-feet.

July 31—Hydrographer, K. T. Thomas: Gage height, 2.80 feet; discharge, 15,393 second-feet.

Aug. 18—Hydrographer, K. T. Thomas: Gage height, 31.70 feet; discharge, 198,718 second-feet.

Daily gage height of Tennessee River at Chattanooga, Tenn., for 1901.

Day	Jan.	Feb.	Mar.	April	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec
1..........	5.2	6.5	3.7	12.4	10.8	12.0	6.0	2.8	9.9	4.2	2.6	2.3
2..........	5.7	6.7	3.7	13.2	9.3	11.1	5.9	2.8	9.8	4.5	2.6	2.2
3..........	5.8	7.2	3.7	19.7	8.5	9.8	6.3	2.9	9.7	4.6	2.5	2.3
4..........	5.6	8.7	3.7	24.1	7.6	8.5	6.4	2.8	10.3	4.5	2.5	2.5
5..........	5.1	10.1	3.8	23.9	7.0	7.7	6.0	2.6	9.4	4.4	2.5	2.5
6..........	4.7	10.0	4.0	22.4	6.7	6.9	5.2	2.6	7.9	4.8	2.5	2.5
7..........	4.4	9.4	4.1	18.9	6.4	6.9	5.1	3.2	6.9	4.5	2.4	3.0
8..........	4.1	8.9	4.1	14.2	6.2	6.9	5.4	9.1	6.4	4.1	2.4	3.2
9..........	3.9	8.5	4.0	11.8	5.9	6.5	5.6	12.2	5.9	3.9	2.4	3.2
10..........	3.8	7.7	7.0	10.3	5.6	6.9	6.3	9.9	5.5	3.7	2.4	3.5
11..........	6.1	7.6	9.8	9.2	5.6	8.2	6.6	7.3	5.3	3.4	2.4	3.5
12..........	15.4	7.0	11.2	8.4	5.4	7.4	5.6	5.8	5.1	3.4	2.4	4.0
13..........	26.6	7.1	9.7	7.9	5.6	6.4	5.0	5.3	5.7	3.5	2.5	4.1
14..........	28.1	7.2	8.2	6.8	5.5	6.1	4.4	6.5	5.9	4.0	2.5	4.7
15..........	25.3	7.0	7.3	9.8	5.5	6.4	4.1	14.0	6.0	4.3	2.5	17.9
16..........	19.5	6.4	6.4	10.3	5.4	7.5	3.6	27.3	6.1	4.1	2.5	26.8
17..........	12.7	5.8	5.8	10.2	5.2	8.9	3.7	32.8	6.3	4.1	2.4	28.8
18..........	9.7	5.3	5.4	9.6	4.9	9.8	3.9	32.6	8.8	4.0	2.4	26.7
19..........	8.1	5.1	5.0	10.8	5.3	9.3	3.7	28.6	9.9	3.7	2.3	19.9
20..........	7.2	5.0	4.7	21.1	8.0	8.9	3.7	23.4	9.3	3.3	2.3	11.4
21..........	6.4	4.9	4.7	26.5	10.2	8.4	4.2	18.6	8.3	3.1	2.2	8.3
22..........	5.9	4.7	4.8	24.7	20.2	7.7	3.9	17.0	7.4	3.1	2.1	6.6
23..........	5.4	4.5	5.2	23.0	26.5	10.1	3.7	16.5	6.4	3.1	2.2	5.7
24..........	5.6	4.4	5.0	22.2	29.7	9.5	3.5	18.5	5.6	3.0	2.5	5.8
25..........	5.8	4.2	5.0	19.0	32.4	7.6	3.1	16.5	5.2	3.0	2.5	6.9
26..........	5.8	4.1	7.7	17.1	32.5	9.6	3.0	13.1	4.9	2.9	2.5	7.9
27..........	5.4	3.8	15.9	14.9	23.5	9.8	2.9	11.0	4.6	2.8	2.6	10.2
28..........	5.2	3.7	22.3	14.9	13.5	8.4	2.9	10.3	4.4	2.7	2.5	16.0
29..........	5.2	......	21.7	14.5	12.1	7.2	2.8	10.7	4.4	2.6	2.5	24.0
30..........	5.2	......	18.4	13.8	11.9	6.4	2.8	10.0	4.3	2.5	2.4	32.0
31..........	5.5	......	14.7	......	12.3	....	2.8	9.8	......	2.5	......	37.4

Rating table of Tennessee River at Chattanooga, Tennessee, for 1901.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second ft.*	*Feet.*	*Second ft.*	*Feet.*	*Second ft.*	*Feet.*	*Second ft*
2.0	11,250	11.6	69,600	21.2	132,000	30.8	194,400
2.1	11,660	11.7	70,250	21.3	132,650	30.9	195,050
2.2	12,080	11.8	70,900	21.4	133,300	31.0	195,700
2.3	12,500	11.9	71,550	21.5	133,950	31.1	196,350
2.4	12,930	12.0	72,200	21.6	134,600	31.2	197,000
2.5	13,360	12.1	72,850	21.7	135,250	31.3	197,650
2.6	13,800	12.2	73,500	21.8	135,900	31.4	198,300
2.7	14,240	12.3	74,150	21.9	136,550	31.5	198,950
2.8	14,680	12.4	74,800	22.0	137,200	31.6	199,600
2.9	15,140	12.5	75,450	22.1	137,850	31.7	200,250
3.0	15,600	12.6	76,100	22.2	138,500	31.8	200,900
3.1	16,080	12.7	76,750	12.3	139,150	31.9	201,550
3.2	16,550	12.8	77,400	22.4	139,800	32.0	202,200
3.3	17,050	12.9	78,050	22.5	140,450	32.1	202,850
3.4	17,550	13.0	78,700	22.6	141,100	32.2	203,500
3.5	18,050	13.1	79,350	22.7	141,750	32.3	204,150
3.6	18,550	13.2	80,000	22.8	142,400	32.4	204,800
3.7	19,050	13.3	80,650	22.9	143,050	32.5	205,450
3.8	19,600	13.4	81,300	23.0	143,700	32.6	206,100
3.9	20,200	13.5	81,950	23.1	144,350	32.7	206,750
4.0	20,800	13.6	82,600	23.2	145,000	32.8	207,400
4.1	21,420	13.7	83,250	23.3	145,650	32.9	208,050
4.2	22,040	13.8	83,900	23.4	146,300	33.0	208,700
4.3	22,660	13.9	84,550	23.5	146,950	33.1	209,750
4.4	23,280	14.0	85,200	23.6	147,600	33.2	210,000
4.5	23,900	14.1	85,850	23.7	148,250	33.3	210,650
4.6	24,520	14.2	86,500	23.8	148,900	33.4	211,300
4.7	25,140	14.3	87,150	23.9	149,550	33.5	211,950
4.8	25,760	14.4	87,800	24.0	150,200	33.6	212,600
4.9	26,380	14.5	88,450	24.1	150,850	33.7	213,250
5.0	27,000	14.6	89,100	24.2	151,500	33.8	213,900
5.1	27,620	14.7	89,750	24.3	152,150	33.9	214,550
5.2	28,240	14.8	90,400	24.4	152,800	34.0	215,200
5.3	28,860	14.9	91,050	24.5	153,450	34.1	215,850
5.4	29,480	15.0	91,700	24.6	154,100	34.2	216,500
5.5	30,100	15.1	92,350	24.7	154,750	34.3	217,150
5.6	30,720	15.2	93,000	24.8	155,400	34.4	217,800
5.7	31,340	15.3	93,650	24.9	156,050	34.5	218,450
5.8	31,960	15.4	94,300	25.0	156,700	34.6	219,100
5.9	32,580	15.5	94,950	25.1	157,350	34.7	219,750
6.0	33,200	15.6	95,600	25.2	158,000	34.8	220,400
6.1	33,850	15.7	96,250	25.3	158,650	34.9	221,050
6.2	34,500	15.8	96,900	25.4	159,300	35.0	221,700
6.3	35,150	15.9	97,550	25.5	159,950	35.1	222,350
6.4	35,800	16.0	98,200	25.6	160,600	35.2	223,000
6.5	36,450	16.1	98,850	25.7	161,250	35.3	223,650
6.6	37,100	16.2	99,500	25.8	161,900	35.4	224,300
6.7	37,750	16.3	100,150	25.9	162,550	35.5	224,950

Rating table for Tennessee River at Chattanooga, Tenn., for 1901.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second Ft.*	*Feet.*	*Second Ft.*	*Feet.*	*Second ft.*	*Feet.*	*Second Ft.*
6.8	38,400	16.4	100,800	26.0	163,200	35.6	225,600
6.9	39,050	16.5	101,450	26.1	163,850	35.7	226,250
7.0	39,700	16.6	102,100	26.2	164,500	35.8	226,900
7.1	40,350	16.7	102,750	26.3	165,150	35.9	227,550
7.2	41,000	16.8	103,400	26.4	165,800	36.0	228,200
7.3	41,650	16.9	104,050	26.5	166,450	36.1	228,850
7.4	42,300	17.0	104,700	26.6	167,100	36.2	229,500
7.5	42,950	17.1	105,350	26.7	167,750	36.3	230,150
7.6	43,600	17.2	106,000	26.8	168,400	36.4	230,800
7.7	44,250	17.3	106,650	26.9	169,050	36.5	231,450
7.8	44,900	17.4	107,300	27.0	169,700	36.6	232,100
7.9	45,550	17.5	107,950	27.1	170,350	36.7	232,750
8.0	46,200	17.6	108,600	27.2	171,000	36.8	233,400
8.1	46,850	17.7	109,250	27.3	171,650	36.9	234,050
8.2	47,500	17.8	109,900	27.4	172,300	37.0	234,700
8.3	48,150	17.9	110,550	27.5	172,950	37.1	235,350
8.4	48,800	18.0	111.200	27.6	173,600	37.2	236,000
8.5	49,450	18.1	111,850	27.7	174,250	37.3	236,650
8.6	50,100	18.2	112,500	27.8	174,900	37.4	237,300
8.7	50,750	18.3	113,150	27.9	175,550	37.5	237,950
8.8	51,400	18.4	113,800	28.0	176,200	37.6	238,600
8.9	52,050	18.5	114,450	28.1	176,850	37.7	239,250
9.0	52,700	18.6	115,100	28.2	177,500	37.8	239,900
9.1	53,350	18.7	115,750	28.3	178,150	37.9	240,550
9.2	54,000	18.8	116,400	28.4	178,800	38.0	241,200
9.3	54,650	18.9	117,050	28.5	179,450	38.1	241,850
9.4	55,300	19.0	117,700	28.6	180,100	38.2	242,500
9.5	55,950	19.1	118,350	28.7	180,750	38.3	243,150
9.6	56,600	19.2	119,000	28.8	181,400	38.4	243,800
9.7	57,250	19.3	119,650	28.9	182,050	38.5	244,450
9.8	57,900	19.4	120,300	29.0	182,700	38.6	245,100
9.9	58,550	19.5	120,950	29.1	183,350	38.7	245,750
10.0	59,200	19.6	121,600	29.2	184,000	38.8	246,400
10.1	59,850	19.7	122,250	29.3	184,650	38.9	247,050
10.2	60,500	19.8	122,900	29.4	185,300	39.0	247,700
10.3	61,150	19.9	123,550	29.5	185,950	39.1	248,350
10.4	61,800	20.0	124,200	29.6	186,600	39.2	249,000
10.5	62,450	20.1	124,850	29.7	187,250	39.3	249,650
10.6	63,100	20.2	125,500	29.8	187,900	39.4	250,300
10.7	63,750	20.3	126,150	29.9	188,550	39.5	250,950
10.8	64,400	20.4	126,800	30.0	189,200	39.6	251,600
10.9	65,050	20.5	127,450	30.1	189,850	39.7	252.250
11.0	65,700	20.6	128.100	30.2	190,500	39.8	252,900
11.1	66,350	20.7	128,750	30.3	191,150	39.9	253.550
11.2	67,000	20.8	129,400	30.4	191,800	40.0	254.200
11.3	67,650	20.9	130,050	30.5	192,450		
11.4	68,300	21.0	130,700	30.6	193,100		
11.5	68,950	21.1	131,350	30.7	193,750		

NOTE—This table applied to the foregoing "daily gage heights" gives the cubic feet per second flowing in the river on each date for which the gage height is given.

Estimated monthly discharge of Tennessee River at Chattanooga, Tennessee.

[Drainage area, 21,382 square miles.]

Month.	Discharge in second-feet			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Depth in inches.	Second-feet per square mile.
1890.						
January	78,470	30,150	42,749	2,628,551	2.31	2.00
February	308,060	44,191	76,081	4,225,310	3.72	3.56
March	445,120	52,906	129,093	7,937,670	6.96	6.03
April	121,464	43,029	64,855	3,859,132	3.38	3.03
May	72,079	41,286	51,200	3,148,186	2.76	2.39
June	41,286	23,400	29,102	1,731,685	1.52	1.36
July	47,677	19,500	27,036	1,662,390	1.45	1.26
August	46,515	21,100	30,881	1,898,810	1.66	1.44
September	47,096	22,200	27,843	1,656,770	1.45	1.30
October	58,135	25,950	37,982	2,335,437	2.04	1.77
November	42,448	20,700	26,394	1,570,549	1.37	1.23
December	77.889	20,400	36,088	2,218,980	1.95	1.69
Per annum	445.120	19,500	48,275	34,873,470	30.57	2.26
1891.						
January	92,995	39,543	59,484	3,657,552	3.21	2.78
February	356,120	59,878	154,822	8,598,380	7.53	7.23
March	381,040	63,364	135,160	8,310,718	7.30	6.32
April	97,643	38.962	61,873	3,681,690	3.22	2.89
May	37,219	26,380	30,215	1,857.860	1.63	1.41
June	47,096	26,840	36,276	2,158,567	1.90	1.70
July	36,057	21,800	26,429	1,625,066	1.43	1.24
August	98,224	23,000	40,402	2,484,238	2.18	1.89
September	36.638	19,200	25,777	1,533,835	1.34	1.20
October	19,200	17,910	18,461	1,135.130	.99	.86
November	41,867	17.440	23,510	1,398,939	1.23	1.10
December	66.269	22.200	39,299	2,416,417	2.12	1.84
Per annum	381.040	17,440	54,309	38,858,392	34.08	2.54
1892.						
January	363,240	41,286	103,453	6,361,118	5.57	4.83
February	69.755	33,733	46,755	2,689,348	2.43	2.25
March	64,526	31,680	45,769	2,814,244	2.47	2.14
April	299.160	40.705	101,287	6,026.982	5.27	4.73
May	53,487	31,160	39,772	2,445,501	2.14	1.86
June	56,972	28.680	43.265	2,574,447	2.25	2.02
July	71,498	26,380	44,520	2,737,446	2.40	2.08
August	31,680	21,800	25,121	1,544,640	1.35	1.17
September	29,660	17,660	21,403	1,273,564	1.11	1.00
October	19,800	17,220	17,952	1,103,833	.97	.84
November	43,610	17,220	27,924	1,661,590	1.45	1.30
December	56,972	21.450	32,793	2,016,376	1.76	1.53
Per annum	363,240	17.220	45,835	33,249,089	29.17	2.15

Estimated monthly discharge of Tennessee River at Chattanooga, Tennessee—Continued.

[Drainage area, 21,382 square miles.]

Month.	Discharge in second-feet.			Total in acre-ft.	Run-off.	
	Maxi-mum.	Mini-mum.	Mean.		Depth in inches.	Second-ft. per sq. mile.
1893.						
January	44,191	22,600	26,812	1,648,616	1.44	1.25
February	283,140	38,381	105.921	5,882,535	5.15	4.95
March	72,660	36,057	50,320	3,094,076	2.71	2.35
April	73,241	31,160	42,137	2,507,326	2.20	1.97
May	224,400	30,150	71,525	4.397.929	3.85	3.34
June	123,207	27,760	49,679	2,956,099	2.59	2.32
July	34,895	21,450	25,741	1,582,763	1.38	1.20
August	33,152	18,410	23,477	1,443,554	1.27	1.10
September	76,727	20,750	33,933	2,019,149	1.77	1.59
October	58,716	18,660	25,550	1,571,018	1.37	1.19
November	31,160	20,400	22,263	1,324,738	1.16	1.04
December	30,640	21,100	24,970	1,535,355	1.35	1.17
Per annum	283,140	18,410	41,861	29,963,158	26.24	1.96
1894.						
January	56,972	22,600	37,389	2,298,975	2.02	1.75
February	151,095	31,680	70,893	3,937,185	3.45	3.31
March	59,297	33,152	46,796	2,877,392	2.53	2.19
April	52,325	27,300	36,287	2,159,222	1.90	1.70
May	44,191	23,800	31,137	1,914,552	1.68	1.43
June	28,680	19,500	21,983	1,308,076	1.15	1.03
July	29,170	18,910	24,486	1,505,595	1.31	1.14
August	30,150	18,910	22,971	1,412,441	1.23	1.07
September	27,300	16,560	19,160	1,140,097	1.00	.90
October	20,750	16,360	17,445	1,072,658	.94	.82
November	20,400	16,360	17,330	1,031,204	.90	.81
December	68,012	16,780	30,862	1.897,643	1.66	1.44
Per annum	151,095	16,360	31,395	22,555,040	19.77	1.53
1895.						
January	261,780	23,400	76,446	4,700,512	4.12	3.57
February	47,096	24,200	35,787	1,987,503	1.74	1.67
March	134,827	42,448	72,341	4.448.103	3.90	3.38
April	78,470	37,219	51,047	3,037,501	2.67	2.39
May	58,135	34,314	43,929	2,701,106	2.37	2.05
June	35,476	21,100	26,417	1,651,917	1.37	1.23
July	63,364	20,750	29,638	1,822,381	1.60	1.39
August	38,381	21,800	26,927	1,655,687	1.45	1.26
September	24,660	16,780	20,316	1,208,883	1.05	.95
October	17,000	16,360	16,665	1,024,698	.90	.78
November	20,750	17,220	18,162	1,080,714	.94	.85
December	33,152	17,660	21,561	1.325,743	1.16	1.01
Per annum	261,780	16,360	36,603	26,564,748	23.27	1.71

Estimated monthly discharge of Tennessee River at Chattanooga, Tennessee—Continued.

[Drainage area, 21,418 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Depth in inches.	Second-ft. per sq. mile.
1896.						
January	50,600	15,554	26,169	1,609,079	1.41	1.22
February	85,052	26,840	55,577	3,196,826	2.79	2.59
March	95,150	22,088	39,257	2,413,834	2.11	1.83
April	409,520	23,276	87,649	5,215,478	4.56	4.09
May	29,216	14,366	20,574	1,265,054	1.10	0.96
June	43,472	17,336	24,365	1,449,815	1.27	1.14
July	130,196	20,306	55,390	3,405,820	2.99	2.59
August	34,562	14,960	22,433	1,379,360	1.21	1.05
September	18,524	9,020	12,346	734,636	.64	.58
October	19,712	8,426	11,588	712,523	.62	.54
November	57,728	9,020	22,603	1,344,969	1.18	1.06
December	45,254	16,148	27,951	1,718,651	1.51	1.31
The year	409,520	8,426	33,825	24,446,045	21.39	1.58
1897.						
January	45,254	16,148	27,932	1,717,483	1.50	1.30
February	308,060	19,712	89,962	4,996,236	4.37	4.20
March	363,240	52,976	165,448	10,173,067	8.90	7.72
April	231,520	36,344	81,056	4,823,156	4.22	3.78
May	134,948	26,543	50,124	3,082,025	2.70	2.34
June	38,126	21,494	29,107	1,731,983	1.52	1.36
July	74,657	21,791	34,428	2,116,909	1.86	1.61
August	34,562	14,366	25,847	1,589,280	1.39	1.21
September	14,960	6,050	8,951	532,620	.47	.42
October	13,772	4,268	7,842	482,189	.43	.37
November	9,614	6,050	7,350	436,164	.38	.34
December	62,183	8,129	24,627	1,514,265	1.33	1.15
The year	363,240	4,268	46,055	33,195,377	29.07	2.15
1898.						
January	124,860	14,344	59,509	3,778,785	3.20	2.77
February	47,115	16,900	22,994	1,277,022	1.11	1.07
March	88,725	15,008	24,774	1,523,304	1.28	1.11
April	121,940	39,085	60,048	3,573,096	3.12	2.80
May	38,720	17,920	23,701	1,457,327	1.28	1.11
June	32,515	10,245	16,395	975,569	.85	.77
July	49,670	11,853	20,063	1,233,633	1.08	.94
August	107,705	20,410	50,638	3,113,629	2.72	2.36
September	174,500	18,190	47,349	2,817,454	2.46	2.21
October	115,370	16,900	44,215	2,718,691	2.38	2.06
November	42,005	20,700	28,415	1,690,806	1.48	1.33
December	35,800	19,000	28,909	1,777,556	1.56	1.35
The year	174,500	10,245	35,584	25,936,872	22.52	1.66

Estimated monthly discharge of Tennessee River at Chattanooga, Tennessee—Continued.

[Drainage area, 21,418 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Depth in inches.	Second-feet per square mile.
1899.						
January	112,560	25,450	47,250	2,905,289	2.55	2.21
February	233,150	30,720	95,554	5,306,801	4.64	4.46
March	244,000	55.210	142,700	8,774,281	7.68	6.66
April	137,360	39,710	69,286	4,122,803	3.59	3.23
May	65,130	22,040	40,450	2.487,173	2.18	1.89
June	35,990	15,600	23,088	1,373,831	1.20	1.08
July	27,930	10,430	15,053	925.573	.81	.70
August	22,040	8,040	11.900	731,702	.64	.56
September	15,840	7,300	10,118	603,063	.53	.47
October	10,635	6,600	7.851	482,739	.43	.37
November	10,635	6,775	8,216	488,886	.43	.38
December	41.880	8,820	22.061	1,356,478	1.19	1.03
The year	244,000	6,600	41,127	29,557,619	25.87	1.09
1900.						
January	54,280	11,660	30,807	1,894,248	1.66	1.44
February	144,800	13.360	52,077	2,892,210	2.53	2.43
March	103,880	42,810	66.020	4,059,412	3.55	3.08
April	70,400	32,820	46,819	2,785,924	2.44	2.19
May	34,440	15,600	21,086	1,296,528	1.13	.98
June	53,040	14,680	33.295	1,981,190	1.73	1.55
July	50,870	13,360	24,674	1,517,145	1.33	1.15
August	34,440	10,020	14,602	897,841	.78	.68
September	25,140	7,300	13,393	796,939	.70	.63
October	42,500	8,040	14,230	874,968	.76	.66
November	92,720	10,840	25,138	1,495,815	1.31	1.17
December	53,040	17,050	29.001	1,783,201	1.56	1.35
The year	144.800	7,300	30,928	22.275.421	19.48	1.44
1901.						
January	189,200	19,600	50,641		2.72	2.36
February	59,850	19,050	36,516		1.77	1.70
March	139,150	19,050	44,952		2.42	2.10
April	166,450	38,400	95.080		4.95	4.44
May	205,450	26,380	68.736		3.70	3.21
June	72,200	33,850	47,673		2.49	2.23
July	37,100	14,680	23.932		1.29	1.12
August	207,400	13.800	75,761		4.08	3.54
September	61,150	22,660	38 859		2.02	1.81
October	25 760	13,360	18.979		1.03	.89
November	13,800	11,660	13,076		.68	.61
December	237,300	12,080	65.509		3.53	3.06
The year	237,200	11,660	48.310		30.68	2.26

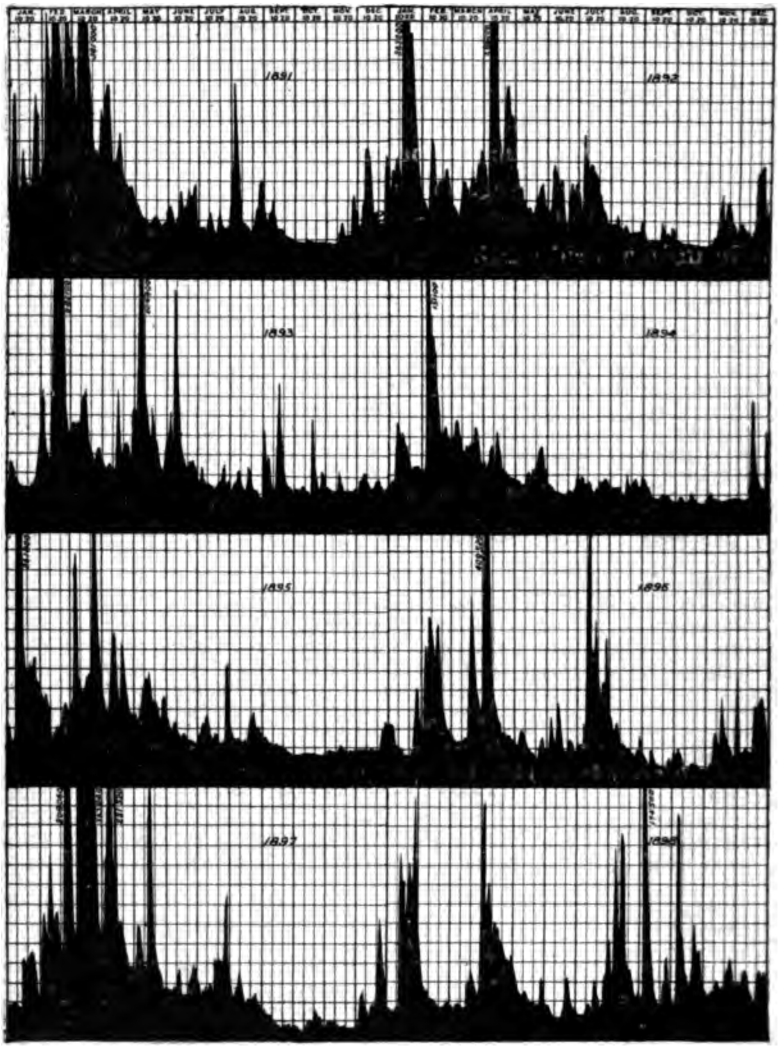

Fig. 16—Discharge of Tennessee River at Chattanooga, Tenn, 1891-1898.

Minimum monthly discharge of Tennessee River at Chattanooga, Tenn., with corresponding net horsepower per foot of fall on a water wheel realizing 80 per cent. of the theoretical power.

	1899.			1900.			1901		
	Minimum cubic feet per second.	Minimum net H. P. per foot of fall.	No. of days duration of minimum.	Minimum cubic feet per second.	Minimum net H. P. per foot of fall.	No. of days duration of minimum.	Minimum cubic feet per second.	Minimum net H. P. per foot fall.	No. of days duration of minimum.
January	25,450	2,314	1	11,660	1,060	1	19,600	1,782	1
February ...	30,720	2,793	1	13,360	1,215	1	19,050	1,732	1
March	55,210	5,019	1	42,810	3,892	2	19.050	1.732	4
April	39,710	3,610	1	32,820	3,075	1	38.400	3.491	1
May	22,040	2,004	1	15,600	1,418	1	26,380	2,398	1
June	15,600	1,418	1	14.680	1,335	1	33,850	3.077	1
July	10,430	948	1	13,360	1,215	2	14.680	1,335	3
August	8,040	731	3	10,020	911	1	13,800	1.255	2
September ..	7,300	664	1	7,300	664	1	22.660	2,060	1
October	6,600	600	3	8,040	731	2	13.360	1,215	2
November ..	6,775	616	2	10,840	985	2	11,660	1,060	1
December ..	8,820	802	2	17,050	1,550	2	12,080	1,098	1

NOTE—To find the minimum net horse power available at a shoal on this stream, near this station, for any month, multiply the total fall of the shoal by the "net H. P. per foot of fall" in this table for that month.

2. SHOALS IN TENNESSEE RIVER NEAR FLORENCE, ALABAMA.

In Tennessee River, in the vicinity of Florence, Ala., (see Fig. 96), are several shoals capable of the development of power in large quantities. The compiler has brought together the data regarding these, his intention being not to discuss the manner in which the immense water power of these shoals can be developed, but to give some idea of its magnitude and the possibility of its utilization.

The shoals are a succession of cascades amid many islands, in a river bed varying in width from a half mile to three miles. The numerous channels thus formed are very irregular in fall and direction. The difference between high and low water is only 5 or 6 feet, corresponding to a rise of 50 feet at Chattanooga. Beginning at Brown's Ferry, 12 miles below Decatur, Ala., the river has the following falls:

From Browns Ferry to the mouth of Elk River the fall is 26 feet in 11 miles. This is known as Elk River Shoals. Its most precipitous part is at the lower end, where there is a fall of 16.5 feet in about 4 miles.

From the mouth of Elk River to the head of Muscle Shoals, a distance of 5 miles, there is a fall of only 2 feet.

From the head of Muscle Shoals to Bainbridge the fall is 85 feet in 17 miles, and is known as Big Muscle Shoals

From Bainbridge to Florence the fall is 23 feet in 7 miles, and is known as Little Muscle Shoals.

From Florence to the head of the Colbert Shoals the fall is 3 feet in 11 miles.

From the head of the Colbert Shoals to Waterloo the fall is 21 feet in 6 miles.

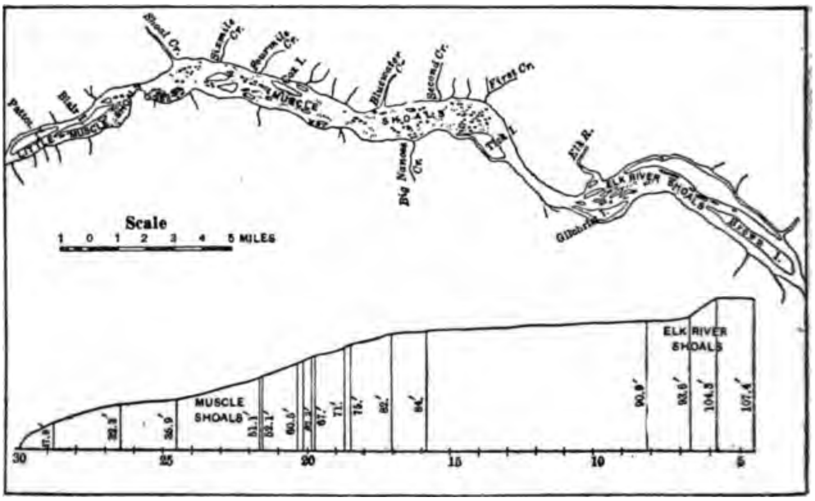

Fig. 17.—Map showing shoals in Tennessee River, near Florence, Ala.

The total fall from Browns Ferry to Waterloo is, therefore, 160 feet in a distance of 57 miles. Sixteen miles of the distance, howeer, has a fall of only 5 feet, leaving a fall of 155 feet in the 41 miles that cover the four shoals mentioned. The shoals are really more precipitous than the foregoing figures would indicate. For instance, 84.6 feet of the fall at Big Muscle Shoals is in a distance of 14 miles.

The bed rock at Elk River Shoals is Carboniferous limestone; that of Muscle Shoals is a hard silicous rock of dark color and flinty structure.

The following is a statement of the minimum discharge of Tennessee River at Chattanooga:

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*The numbers 5 to 30 at bottom of cut represent miles.

	Sec.-ft.
From 1890 to 1895, inclusive	16,[illegible]
From 1896 to 1900, inclusive	6,600
From January 1 to November 16, 1901, inclusive	12,930

From this it is estimated that 6,600 second-feet is the minimum discharge for driest years, and that 12,930 second-feet is the minimum for average years. Assuming that tributaries entering the river below Chattanooga will safely supply all of the water needed for lockage, we can use these discharges in estimating the water power of these shoals, which are about 200 miles below Chattanooga, by river, and drain an area more than 7,000 square miles greater than the watershed above Chattanooga.

Estimated minimum net horsepower of Tennessee River in Alabama on turbines realizing 80 per cent. of the theoretical power.

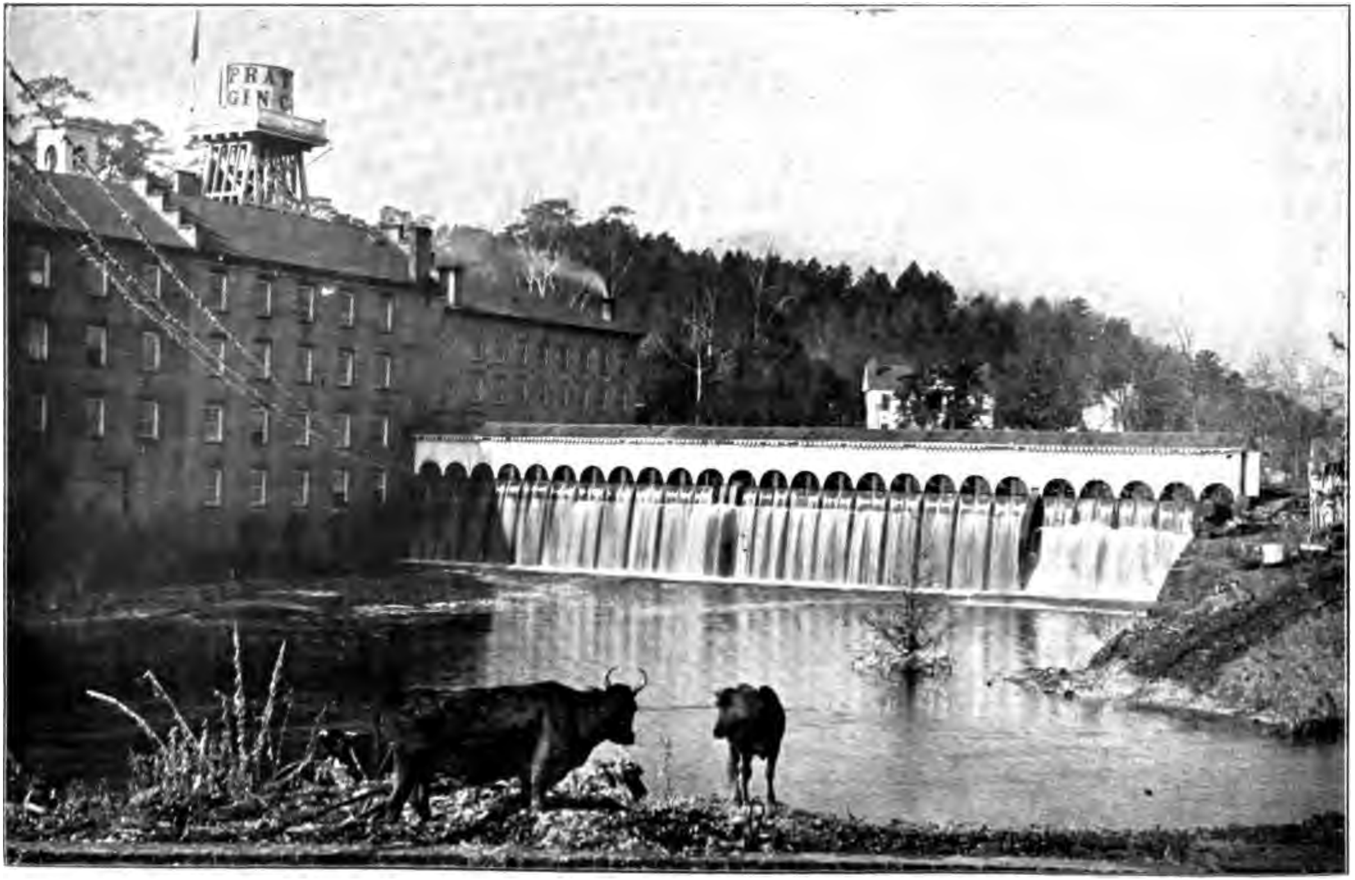
Locality.	Fall	Minimum net power in driest years.	Minimum net power in average years.
	Fall.	*Horsepower.*	*Horsepower.*
Elk River Shoals	26	15,600	30,550
Big Muscle Shoals	85	51,000	99,875
Little Muscle Shoals	23	13,800	27,025
Colbert Shoals	21	12,600	24,675
Total	155	93,000	182,125

The foregoing table assumes that the total fall can in each case be utilized. While this assumption is not correct, it stands as an offset to the assumption that the water supply available will be as low as the minimum discharge at Chattanooga, 200 miles above. The drainage area above Chattanooga is 21,418 square miles, while the drainage area above the shoals under consideration is about 29,000 square miles. It may therefore safely be assumed that the actual power available for development at the shoals is greater than that shown by the table.

The foregoing statements of fall and distance are from a report by Mr. William B. Gaw, chief assistant engineer, United States Army, 1868, and the map and profile are from drawings prepared under the direction of Lieut. Col. J. W. Barlow, United States Engineers, 1890.

3. TRIBUTARIES OF TENNESSEE RIVER.

Paint Rock Creek, Elk River, Shoal Creek, Flint Creek, Big Nance Creek, Town Creek, and Big Bear Creek are all large streams, and most of them have fine undeveloped water powers. But no surveys have been made of them, and no measurements of discharge so far. There are also many large bold springs in this basin, that are said to have a pure and unfailing water supply, but the Hydrographic Survey has not reached them, and no report can be made on them at this time.



[illegible] Creek, Prattville, Ala.

CHAPTER VIII.

UTILIZED WATER POWERS OF ALABAMA.

The following is a list by counties of the water powers that are utilized. The most of these powers are small, but they make a large aggregate, and they represent only an insignificant part of the power that is capable of development.

*AUTAUGA COUNTY.

	NAME.	POSTOFFICE.	INDUSTRY.	H. P.
*	**Charity** P. Carter	Billingsley	flour and grist mill	15
	Montgomery's Mill	Prattville	flour and grist mill	30
	Public Grist Mill	Billingsley	flour and grist mill	9
	Parker's Mill	Milton	flour and grist mill	20
	Dawson's Mill	Netezen	lumber and timber mill	20
	Ellis Mill	Jones Switch	lumber and timber mill	4
	Long Leaf Yellow Pine Saw Mill	Autaugaville	lumber and timber mill	15
	Ray's Saw Mill	Jones Switch	lumber and timber mill	10
	Swift Creek Mill Co. (Swift Creek)	Autaugaville	lumber and timber mill	70
	John H. Herod	Netezen	lumber and timber mill	6
	Prattville Cotton M. & Banking Co. (Autauga Creek)	Prattville	cotton goods. The dam at Prattville is shown in Plate D opposite	200
†	**Continental** Gin Co., (Autauga Creek)	Prattville	cotton gin	
	Prattville Ice Factory (Autauga Creek)	Prattville	ice factory	
	Doster Ginnery (Autauga Creek)	Prattville	cotton gin	
	G. H. Roy	Vine Hill	cotton gin	

WATER POWER AT PRATTVILLE.

The water power at Prattville was first developed about 1830, when it was used by a man named May to operate a small saw mill. About 1833 this water power and the adjacent lands were purchased by Mr. Daniel Pratt, who then erected a cotton gin factory, which was driven by the water power. The dam at that time was about eight feet high. A number of years after the purchase of this property by Mr. Pratt he increased the dam so that it now has a height of 16 feet, and is built of brick. At present it is used jointly by the Prattville Cotton Mills & Banking Company and the Continental Gin Company, the former using about 255 horse-power and the latter about 100 horse-power. About half a mile below the dam above referred to is another dam affording about 8 feet head, and owned by the M. E. Pratt estate. This power operates a grist mill, cotton ginnery and ice factory, and the water wheel at that point has a rated capacity of 54 horse-power. About one mile above the dam of the Cotton Mill and Gin Company, there was formerly another dam 12 feet high, which afforded power for a cotton mill. This mill, however, was burned a number of years ago, and the dam has been allowed to go to ruin. It would probably afford 200 horse-power, or possibly a little more, should it be rebuilt.

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*From U. S. Census, 1900.

†From report of Probate Judge.

There is also a dam about two miles below Prattville known as the Montgomery mill property. This dam is about 12 feet high and affords power for a grist mill and ginnery. Only a small portion of the available power is used. It could afford, easily, 250 horse-power if the proper wheels were installed.

*BARBOUR COUNTY.

NAME.	POSTOFFICE.	INDUSTRY.	H. P.
Hagler's Mill	Louiville	flour and grist mill	17
Carpenter's Mill	Louisville	flour and grist mill	15
Hoffman's Mill	Clayton	flour and grist mill	50
Hartman's Mill	Clayton	flour and grist mill	10
Zorn Mills	Lodi	flour and grist mill	8
William M. Wood	Bush	flour and grist mill	12
Will Stewart	White Oak Springs	flour and grist mill	12
Winn's Mill	Clayton	flour and grist mill	12
John White	Spivey	flour and grist mill	10
Weston's Mill	Louisville	flour and grist mill	8
H. J. Turner	White Oak Springs	flour and grist mill	10
Spencer's Mill	Clayton	flour and grist mill	10
Perkin's Mill	Elamville	flour and grist mill	12
Angus McSwain	White Oak Springs	flour and grist mill	12
William Johnson	Clayton	flour and grist mill	10
John M. Jenkins	Starhill	flour and grist mill	10
Solomon's Mills	Solomon's Mills	flour and grist mill	25
Danner Mill	Elamville	flour and grist mill	12
William H. Chambers	Oateston	flour and grist mill	12
Wilson Deshazo	Cottonhill	flour and grist mill	16

BIBB COUNTY.

	NAME.	POSTOFFICE.	INDUSTRY.	H. P.
*	Scottsville Flour & Grist Mill	Scottsville	flour and grist mill	30
	Palmetto Flouring & Grist Mill	Brierfield	flour and grist mill	30
	Williams Grist Mill	Blocton	flour and grist mill	10
	William S. Mathews	Data	flour and grist mill	8
	Six Mile Custom Mill	Six Mile	flour and grist mill	15
	Mayfield Bros.	Mertz	lumber and timber mill	29
†	Scottsville, Wool Carder	Scottsville	woolen goods	20
	J. M. Battle, (Six Mile Creek)	Six Mile	flour and grist mill.	50
	W. C. Trott, (Six Mile Creek)	Six Mile	cotton gin and grist mill	50
	W. H. Thomas, (Six Mile Creek)	Ashley	lumber and grist mill	35
	Dock Mahan, (Mahn's Creek)	Brierfield	wool carder and grist mill	40

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*From U. S. Census, 1900.

†From report of Probate Judge.

	NAME.	POSTOFFICE.	INDUSTRY.	H. P.
†	Bessemer Land & Improvement Co. (Schultz Creek)	Lopez	wool carder, grist mill and cotton gin	100
	R. R. McCally, (Hills Creek)	Blocton	gin, lumber and grist	30
	E. M. Timbro, (Schultz Creek)	Centerville	grist mill	30
	F. H. James, (Haysoppy Creek)	Centerville	grist mill	20
	A. L. Elam, (Affonee Creek,)	Affonee	grist mill	15

*BLOUNT COUNTY.

	Logan Snead	Snead	flour and grist mill	10
	E. B. Head	Gum Spring	flour and grist mill	16
	E. R. Wood	Wynnville	flour and grist mill	8
	Hendrick's Mill	Swansea	flour and grist mill	30
	Jones M. Burns	Clarence	flour and grist mill	15
	Wilson Adcock	Tidmore	flour and grist mill	10
	G. M. D. Tidwell & Sons	Tidwell	flour and grist mill	20
	Alldridge & Brother	Liberty	flour and grist mill	10
	Brittain Mill	Summit	flour and grist mill	20
	Morris' Mill	Ensley	flour and grist mill	10
	Rufus F. Wyatt	Bangor	flour and grist mill	10
	Sam Mardis	Blountsville	flour and grist mill	60
	Jno. H. Donahoo & Geo. W. Darden	Rosa	lumber and timber	20

BULLOCK COUNTY.

	Brooks' Mill	Mascotte	flour and grist mill	6
	Union Springs Waste Mill	Union Springs	flour and grist mill	15
	Chappell's Grist Mill	Union Springs	flour and grist mill	10
	D. H. Mason, (McBride's Creek)	Indian	lumber, gin and grist	20
	From report of Probate Judge.			
	†Chas. Radford, (Conecuh Creek)	Union Springs	grist mill	10

*BUTLER COUNTY.

	John W. Halso	Pigeon Creek	flour and grist mill	10
	Glen Graham	Pontus	flour and grist mill	6
	The Four Mile Mill	Greenville	flour and grist mill	10
	The N. M. Rhodes Mill & Mercantile Co.	Shell	flour, grist and lumber mill	50
	Mrs. M. E. Crane	Monterey	flour and grist mill	15
	Rouse & Whiddon	Greenville	flour and grist mill	50

CALHOUN COUNTY.

*	Joseph Francis	Cane Creek	flour and grist mill	50
	Richey Mill	Jacksonville	flour and grist mill	20
	Canada Grist Mill	Womack	flour and grist mill	16
	Cold Water Mills	Cold Water	flour and grist mill	20
	Read's Mill	Reads	flour and grist mill	60
	Luther Barton	Piedmont	flour and grist mill	20
	W. F. McCulley	Oxford	flour and grist mill	20
	A. McCurdy	White Plains	flour and grist mill	34
	Morris Grist Mill	Morrisville	flour and grist mill	18
	Nisbet's Mill	Jacksonville	flour and grist mill	30
	James A. Weatherly	DeArmanville	flour and grist mill	8

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*From U. S. Census, 1900.

†From report of Probate Judge.

	NAME. POSTOFFICE. INDUSTRY.	H. P.
*	Wood Milling Co., Ohatchee, flour and grist mill	26
	Davis & Henderson, Piedmont, flour and grist mill	24
	Hendon's Grist Mill, Iron City, flour and grist mill	10
	Hughes' Saw Mill, Oxford, lumber and timber mill	28
‡	F. M. Whiteside, (Choccolocco Creek), White Plains	25 or 30
	Downing & Morris, (Choccolocco Creek), Choccolocco	50
	J. T. DeArman, (Choccolocco Creek), Anniston	15
	W. E. Mellon, (Choccolocco Creek), Oxford	40
	Lee's Mill, (Choccolocco Creek), Oxford	30
	T. G. Slaughter, (Choccolocco Creek), Oxford	15
	J. H. Savage, (Terrapin Creek), Anniston	20
	J. H. Savage, (Terrapin Creek), Anniston	20
	Frank Aderhold, (Nances Creek), Ladiga	20
	John Ramagnand, (Champion Creek), Jacksonville	15
	James Crook, (Tallasseehatchee Creek), Jacksonville	10
	W. J. Edmondson, (Tallasseehatchee Creek), Anniston	30
	W. A. Prickett, (Tallasseehatchee Creek), Alexandria	10
	Beaty Estate, (Tallasseehatchee Creek), Alexandria	30
	Peter Heifner, (Tallasseehatchee Creek), Alexandria	15
	James Aderhold, (Ohatchee Creek), Reads	20
	Pleas. Martin, (Ohatchee Creek), Peekshill	25
	C. J. Wood, (Ohatchee Creek), Jacksonville	30
	Wm. Thompson, (Ohatchee Creek), Peekshill	8
	R. L. Treadway, (Tallasseehatchee Creek), Anniston, R. F. D	10
	J. H. Francis, (Tallasseehatchee Creek)	25
	R. H. Cobb, (Tallasseehatchee Creek), Anniston	20
	G. W. S. Loyd, (Cane Creek), Peaceburg	10
	Mrs. Loyd, (Cane Creek), Peaceburg, gin	6
	Morris Mfg. Co., (Cane Creek), Morrisville, shops	30
	E. G. Morris, (Cane Creek), Morrisville	30
	P. H. Brothers, (Cane Creek), Zula	30
	J. H. Francis, (Cane Creek)	50

*CHAMBERS COUNTY.

D. E. M. Smith, Barber, flour and grist mill	24
Cumbees Grist Mill, Stroud, flour and grist mill	20
Thomas H. Fuller, Lafayette, flour and grist mill	10
R. T. Humphrey, West Point, Ga., flour and grist mill	42
J. T. Hudson, Hickory Flat, flour and grist mill	4
Wyche Robinson, Lafayette, flour and grist mill	16
Stephens' Mill, Driver, flour and grist mill	8
Ripville Mills, Wise, flour and grist mill	20
Charles F. Higins, Finley, flour and grist mill	20
J. E. Dixon, Lafayette, flour and grist mill	10
Ratchford & Tucker, Lafayette, flour and grist mill	10
Benjamin F. Knight, Lafayette, flour and grist mill	10
Wooddy & Beall, Moorefield, flour and grist mill	6
Leverett's & Abernathy's Mill, Milltown, flour and grist mill	4
John B. Calhoun, Camphill, flour and grist mill	8
G. L. Leverett, Lafayette, flour and grist mill	16
West Point Mfg. Co., West Point, cotton goods	1,100

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*From U. S. Census, 1900.
†From report of Probate Judge.
‡From report of L. J. Morris.

CHEROKEE COUNTY.

	NAME.	POSTOFFICE.	INDUSTRY.	H. P.
*	Shamblin & Toles Mill	Broomtown	flour and grist mill	8
	Chandler & Stinson	Center	flour and grist mill	20
	Shamblin & Toles Mill	Broomtown	flour and grist mill	20
	J. A. Lumpkin	Forney	flour and grist mill	13
	Hurleys Mill	Hurley	flour and grist mill	12
	Tyre G. Craig	Grover	flour and grist mill	12
	Rush Mill	Lawrence	flour and grist mill	10
	E. W. Ragdale	Spring Garden	flour and grist mill	30
	W. F. Timmerman	Round Mountain	flour and grist mill	8
	M. E. Cohia	Cedar Bluff	flour and grist mill	24
	M. J. Abernathy	Pleasant Gap	lumber and timber mill	15
	Hurricane Creek Mfg. & Min. Co.	Spring Garden	cotton goods	65
†	W. A. Stinson, (Terrapin Creek)	Center	gin, flour and grist	60
	J. J. Scroggin, (Terrapin Creek)	Coloma	gin, flour and grist	60
	T. F. Stewart, (Terrapin Creek)	Spring Garden	flour and grist	60
	J. M. Adderhold, (Mill Creek)	Piedmont	flour, grist and gin	40
	M. L. Braswell, (Hurricane Creek)	Pleasant Gap	flour & grist	40
	B. F. Newberry, (Yellow Creek)	Round Mountain	flour, grist, and gin mill	40
	E. Cobia, (Chattooga River)	Cedar Bluff	flour, grist, and gin	60
	R. A. Russell & Co. (Chattooga River)	Gaylesville	flour, grist and gin mill	60
	W. F. Henderson, (Mill Creek)	Fullerton	flour, grist and gin	40
	Rush & Rinehart, (Chattooga River)	Fullerton	flour, grist, gin	60
	J. G. Toles, (Mill Creek)	Broomtown	grist and gin mill	40
	Elliott Bros., (North Spring Creek)	Grassland	grist and gin	40
	J. T. Webb & Bros., (Spring Creek)	Hurley	grist and gin mill	40
	J. D. Jordan, (South Spring Creek)	Noah	grist and gin mill	20

*CHILTON COUNTY.

James Dorming	Jemison	flour and grist mill	10
Mahan's Mill	Clanton	flour and grist mill	20
W. W. Sansome	Adams	flour and grist mill	12
Honeycutt Mill	Jemison	flour, grist, lumber and timber mill	20

*CHOCTAW COUNTY.

Pink Blackwell	Hinton	flour and grist mill	12
Aquilla Mills	Aquilla	lumber and timber mill	16

*CLARKE COUNTY.

Gate's Mill	Vashti	flour and grist mill	30
Fleming's Grist Mill	Nealton	flour and grist mill	10
Dacy's Mill	Whatley	flour and grist mill	5

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*From U. S. Census, 1900.

†From report of Probate Judge.

*CLAY COUNTY.

NAME.	POSTOFFICE.	INDUSTRY.	H. P.
Henry F. Smedley	Mellow Valley	flour and grist mill	15
Hezakiah Ingram	Hatchett Creek	flour and grist mill	10
Allen P. Jenkins	Delta	flour and grist mill	14
Knight's Mill	Wesobulga	flour and grist mill	14
F. M. Munroe	Millerville	flour and grist mill	40
John R. Gilbert	Pinckneyville	flour and grist mill	8
Hodnett & Co.	Hat	flour and grist mill	10
Moses R. Watts	Dean	flour and grist mill	6
Thomas J. Watts	Shinbone	flour and grist mill	8
Bishop, Carpenter & Co.	Cherrry	flour and grist mill	10
Cockrell & Mitchell	Goldburg	flour and grist mill	14
McRairie, Gladney & Co.	Cherry	flour and grist mill	20
Virginia Whellen	Coleta	flour and grist mill	6
Stephens & East	Delta	flour and grist mill	4
Deberry & Griffin	Flatrock	flour and grist mill	15
Child's Mill	Swann	flour and grist mill	5
James B. Brown	Pinckneyville	flour and grist mill	6
James J. Bachus	Fishhead	flour and grist mill	24
Brooks & Handley	Hatchett Creek	flour and grist mill	8
Columbus Bell	Lineville	lumber and timber mill	10
J. C. Kennedy	Fishhead	lumber and timber mill	14
William M. Patterson	Meadow	lumber and timber mill	30
Ward & Ford	Lineville	lumber and timber mill	15

*CLEBURNE COUNTY.

NAME.	POSTOFFICE.	INDUSTRY.	H. P.
J. T. & E. W. Beason	Beasons Mill	flour and grist mill	10
W. M. Evans	Edwardsville	flour and grist mill	20
Robert Mill	Oaklevel	flour and grist mill	16
Teague & Co.	Eudora	flour and grist mill	13
H. F. Alsabrook	Borden Springs	flour and grist mill	30
Buttram's Mill	Bucham	flour and grist mill	20
John A. Brown	Bell Mills	flour and grist mill	16
John I. Burgess	Edwardsville	flour and grist mill	20
Wade H. Barnes	Muscadine	flour and grist mill	4
J. W. Conner	Chulafinnee	flour and grist mill	6
Lyon & Killebrue		flour and grist mill	34
W. G. Miligan	Oakfuskee	flour and grist mill	8
James McMahan	Edwardsville	flour and grist mill	12
E. W. Pitchford	Oaklevel	flour and grist mill	15
William J. Thrash	Oakfuskee	flour and grist mill	6
Wade H. Barnes	Muscadine	flour and grist mill	30
W. H. Tumlin & D. S. Baber	Ai	flour and grist mill	16

*COFFEE COUNTY.

NAME.	POSTOFFICE.	INDUSTRY.	H. P.
Levy Wise	Ino	flour and grist mill	5
Bell Mill	Dot	flour and grist mill	8
Lenora F. Hildreth	Enterprise	flour and grist mill	17
Harper Flour Mills	Brockton	flour and grist mill	4
F. M. Prestwood	Fresco	flour and grist mill	20
McIntosh Mill	Eta	flour and grist mill	8
Wise's Lower Mill	Elba	flour and grist mill	12
Wise's Upper Mill	Elba	flour and grist mill	10
Buck & Co.	Penn	lumber and timber mill	50

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*From U. S. Census, 1900.

*COLBERT COUNTY.

NAME.	POSTOFFICE.	INDUSTRY.	H. P.
George Martin	Allsboro	flour and grist mill	8
James Burns	Mand	flour and grist mill	4
Tuscumbia Mill	Tuscumbia	flour and grist mill	40
C. C. Hester	Tuscumbia	flour and grist mill	40
Chambee's Grist Mill	Tuscumbia	flour and grist mill	8
Dillard's Mills	Russellville	lumber and timber	12
Steenson's Mill	Sheffield	lumber and timber	30

*CONECUH COUNTY.

George Stenson	Bonnette	flour and grist mill	12
James B. Pate	Brooklyn	flour and grist mill	5
William M. Robinson	Brooklyn	flour and grist mill	5
Jimson C. Cox	Gem	flour and grist mill	5
John N. Varner & Chas. M. Varner	Herbert	flour and grist	10
James E. Wilson	Mount Union	flour and grist mill	20
Ransom H. Finley	Zern	flour and grist mill	8
G. G. Broker	Bowles	lumber and timber mill	10
Cary & Johnston	Brooklyn	lumber and timber mill	15
T. N. Piggott	Gravella	lumber and timber mill	40
Robinson Bros.	Brooklyn	lumber and timber mill	30
H. J. Robinson	Burnt Corn	lumber and timber mill	40
Henry Wills	Finklet	lumber and timber mill	30

*COOSA COUNTY.

Miller's Mill	Bentleyville	flour and grist mill	20
Nolen's Mill	Darden	flour and grist mill	15
J. T. M. Hodnett & O. P. Hodnett	Equality	flour and grist mill	12
W. N. Neighbors	Goodwater	flour and grist mill	23
Smith's Mill	Nixburg	flour and grist mill	10
George P. Waits	Rockford	flour and grist mill	8
Crawford Mill	Rockford	flour and grist mill	4
Lawson Grist and Saw Mill	Rockford	lumber and timber mill	36

*COVINGTON COUNTY.

A. J. Fletcher	Andalusia	flour and grist mill	10
Uatu Grist Mill	Andalusia	flour and grist mill	10
William Sharp	Ealums	flour and grist mill	10
Davis B. Gantt	Gantt	flour and grist mill	12
C. E. Rawls	Gantt	flour and grist mill	10
Dorsey's Mill	Glasiasko	flour and grist mill	10
James Aplin	Green Bay	flour and grist mill	20
William Watkins	Liberty Hill	flour and grist mill	8
Kearsey's Mill	Redlevel	flour and grist mill	5
Ephram F. Lassiter	Rosehill	flour and grist mill	10
Thomas Saw Mill	Redlevel	lumber and timber mill	25
Simmons Mill	Beck	lumber and timber mill	40
J. A. Prestwood, Jr.	Andalusia	lumber and timber mill	40
George W. Lee	Rat	lumber and timber mill	20
Buck Creek Mill	River Falls	lumber and timber	80
J. F. Guthrie	Vera Cruz	lumber and timber mill	25
Gunter's Mill	Andalusia	lumber and timber mill	40
Gunter's Saw Mill	Gantt	lumber and timber mill	15
Gantt's Mill	River Falls	lumber and timber mill	70
Pollard Gantt	Searight	lumber and timber mill	35
Davis B. Gantt	Gantt	lumber and timber mill	40
N. B. Dixon	Mason	lumber and timber mill	60
Bartlett & Barker		lumber and timber mill	60

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*From U. S. Census, 1900.

*CRENSHAW COUNTY.

NAME.	POSTOFFICE.	INDUSTRY.	H. P.
E. P. Lasseter	Bullock	flour and grist mill	8
G. B. Morgan	Bullock	flour and grist mill	15
Folmar's Mill	Goshen	flour and grist mill	8
N. Skipper	Honoraville	flour and grist mill	10
Daniel & Co.	Lapine	flour and grist mill	30
John S. Marsh	Rutledge	flour and grist mill	20
G. B. Sasser	Luverne	flour and grist mill	15

*CULLMAN COUNTY.

NAME.	POSTOFFICE.	INDUSTRY.	H. P.
Joseph W. Hyatt	Baileyton	flour and grist mill	10
Miles Humphries	Baileyton	flour and grist mill	4
D. H. Laney	Battleground	flour and grist mill	6
Robert J. Waldrop	Cranehill	flour and grist mill	20
Andrew J. Miller	Summit	flour and grist mill	6

*DALE COUNTY.

NAME.	POSTOFFICE.	INDUSTRY.	H. P.
Archer McCall	Candy	flour and grist mill	10
Floyd Mill	Dothan	flour and grist mill	10
Lewis Mill	Clopton	flour and grist mill	15
Murphy Mill	Dothan	flour and grist mill	5
Maunds Corn Mill	Ewells	flour and grist mill	10
Pope's Mill	Grimes	flour and grist mill	60
Charles Thrower	Kleg	flour and grist mill	16
Daniel McSwean	Ozark	flour and grist mill	20
Preston's Mill	Peach	flour and grist mill	20
The Kelley Grist Mill	Pinckard	flour and grist mill	150
Atkinson's Saw Mill	Newton	lumber and timber mill	16
J. F. Bell	Daleville	lumber and timber mill	22

*DALLAS COUNTY.

NAME.	POSTOFFICE.	INDUSTRY.	H. P.
Calhoun's Mill	Carlowville	flour and grist mill	10
Ivey & Williams	Morrowville	flour and grist mill	8

DEKALB COUNTY.

*

NAME.	POSTOFFICE.	INDUSTRY.	H. P.
L. D. Wooten	Blake	flour and grist mill	8
J. D. Hall	Chavies	flour and grist mill	10
J. S. Ward	Chumley	flour and grist mill	12
Kean & Warren	Cordell	flour and grist mill	20
Swindell's Mill	Cotnam	flour and grist mill	12
Griffin's Mill	Cotnam	flour and grist mill	12
Emeline Clayton	Crossville	flour and grist mill	6
Swader's Mill	Dekalb	flour and grist mill	15
James Clark	Eula	flour and grist mill	15
David J. Harper	Floy	flour and grist mill	3
Elrod's Grist Mill	Flay	flour and grist mill	4
Davis Mill	Fort Payne	flour and grist mill	16
Thomas F. Everett	Luna	flour and grist mill	8
Elrod's Mill	Geraldine	flour and grist mill	30
Pruitt's Mill	Skirum	flour and grist mill	12
Lebanon Flour & Grist Mill	Lebanon	flour and grist mill	36
Robert F. Ellison	Mentone	flour and grist mill	25
Ellic Ellsworth	Opnir	flour and grist mill	6
Warren's Grist Mill	Portersville	flour and grist mill	12

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*From U. S. Census, 1900.

NAME. POSTOFFICE. INDUSTRY.	H. P.
John F. Williams, Rains, flour and grist mill	8
Edward W. Williams, Rains, flour and grist mill	6
McGee's Mill, Sand Rock, flour and grist mill	5
Charles G. Matheny, Sauty Mills, flour and grist mill	20
Dixie Mills, Sulphur Springs, flour and grist mill	10
* Phillips' Mill, Valleyhead, flour and grist mill	4
The Roberts Mill Co., Collinsville, flour and grist mill	25
W. E. Brown & Son, Sulphur Springs, lumber and timber mill	15
James M. Durham, Chavies, lumber and timber mill	16
William C. Hill & Co., Blanche, lumber and timber mill	40
D. D. Hughes, Hughes, lumber and timber mill	15
Ward, Pickens & Co., Dawson, lumber and timber mill	15
John A. Davis, (Wills Creek), Fort Payne, grist mill and gin	
M. S. Brown and W. C. Thomas, (Lookout Creek), Sulphur Springs, flouring mill	
† D. D. Hughes, (Wills Creek), Hughes P. O.; flour & grist mill	
P. M. Frazier, (Wills Creek), Lebanon, flour and grist mill	
S. D. Warren, (Wills Creek), Lebanon, flour and grist mill	
Grif. Elrod, (Town Creek), South Hill, flour and grist mill	
Durham & Co., (Town Creek), Chavies, flour, grist & saw mill	

*ELMORE COUNTY.

E. & H. T. Andrews, Channahatchee, flour and grist mill	25
Benjamin Spigener, Elmore, flour and grist mill	5
Sykes Mill, Sykes Mill, flour and grist mill	16
John C. Birt (Lancaster Old Mill,) Tallassee, flour and grist	24
Freeman's Grist Mill, Tallassee, flour and grist mill	5
J. J. Benson, Kowaliga, lumber and timber mill	20
J. T. Rogers, Spigners, lumber and timber mill	36
(From Chapter III.)	
‡Tallassee Falls Mfg. Co., (Tallapoosa River,) Tallassee, cotton and woolen goods	8,900
Montgomery Power Co. (Tallapoosa River), Tallassee, electric transmission to Montgomery, Ala.	5,600

*ESCAMBIA COUNTY.

Bradley Mill, flour and grist mill	10
S. S. Overstreet, Roberts, flour and grist mill	20
James F. Douglas, Mason, lumber and timber	25

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*From U. S. Census, 1900.

‡This is the same company that is now organized under the name of the Mt. Vernon Woodbury Cotton Duck Company, with office at Montgomery, Ala.

ETOWAH COUNTY.

	NAME.	POSTOFFICE.	INDUSTRY.	H. P.
*	Wesson Mills	Attalla	flour and grist mill	25
	Cox & Brother	Avery	flour and grist mill	6
	B. H. Rogers	Etowahton	flour and grist mill	40
	T. G. Ewing	Ewings	flour and grist mill	60
	John C. Rollins	Fenton	flour and grist mill	8
	Reese Mill	Hill	flour and grist mill	10
	John H. Helms	Ballplay	flour and grist mill	6
	Ford & Sibert's Mill	Hokes Bluff	flour and grist mill	30
	Morgan & Cochran	Keener	flour and grist mill	8
	W. J. Harris	Nix	flour and grist mill	12
	John B. Burns	Seaborn	flour and grist mill	8
	A. B. Stephens	Seaborn	flour and grist mill	8
	W. H. Cobb	Steels Depot	flour and grist mill	20
	P. C. Turner	Walnut Grove	flour and grist mill	30
	P. C. Turner	Walnut Grove	woolen goods	13
	W. M. Brothers & Son	Gallant	woolen goods	8
	Gadsden Times-News	Gadsden	printing and publishing	4
†	J. M. Morague, (Big Wills Creek)	Gadsden	grist mill	100
	Wm. McClendon, (Big Wills Creek)	Attalla	grist mill	40
	— Griffith, (Big Wills Creek)	Keener	grist mill	35
	Bob Rigers, (Big Canoe Creek)	Gadsden	grist mill	75
	Tom Ewing, (Cane Creek)	Gadsden	grist mill	40

FAYETTE COUNTY.

	NAME.	POSTOFFICE.	INDUSTRY.	H. P.
*	Rodolphus Cotton	Bankston	flour and grist mill	20
	D. G. Hester	Covin	flour and grist mill	12
	John W. Anthony	Glenallen	flour and grist mill	30
	Landon Miles	Hester	flour and grist mill	13
	Bishop Emick	Rena	lumber and timber mill	40
	Phillip N. Fortenberry	Bankston	lumber and timber mill	8
†	W. L. Caine, (Sipsey River)	Fayette	saw and grist mill	40
	T. E. Newton & Bro., (Sispey River)	Fayette	saw and grist	40
	Licurgas Ray, (Luxapelila Creek)	Montcalm	saw and grist	30
	John Barnes, (Luxapelila Creek)	Covin	gin and grist mill	30
	E. Bishop, (Luxapelila Creek)	Rainy	saw, gin and grist mill	30
	John Williams, (Luxapelila Creek)	Covin	gin and grist mill	30
	Washington Hubbert, (Shirley Creek)		gin and grist mill	10
	Gilpin & Jones, (Shirley Creek)		saw, gin and grist mill	16
	Jones & Jones, (Shirley Creek)	Hugent	saw, gin & grist mill	20
	P. N. Fortenberry, (Davis Creek	Bankston	saw, gin and grist	8
	G. H. White, (Davis Creek)	Davis Creek	saw, gin and grist	16
	J. W. Blackburn, (Davis Creek)	Davis Creek	saw, gin & grist	18
	M. I. Barnette, (Davis Creek)	Ridge	saw, gin and grist mill	20
	Dolphus Cotton, (Clear Creek)	Bankston	saw, gin and grist	16
	M. Miller, (Clear Creek)	Bankston	saw, gin and grist mill	
	John G. Kizer, (North River)	Berry Station	saw, gin & grist	40
	Marshall Jones, (Bear Creek)	Bear	saw, gin and grist mill	20
	R. G. Walker, (Bear Creek)	Bear	saw, gin and grist mill	24
	Landon Miles, (Stewart Creek)	Hester	grist mill	12
	J. T. McCaleb, (Mountain Creek)	New River	grist mill	16
	W. A. Ayers, (Beaver Creek)	Fayette	gin and grist mill	12
	G. W. Gray, (Boxes Creek)	Stough	grist mill	16
	Miles Whitson, (Clear Creek)	Handy	grist mill	12
	Bud Wade, (Hollingsworth Creek)	New River	grist mill	12

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*From U. S. Census, 1900.

†From report of Probate Judge.

*FRANKLIN COUNTY.

NAME.	POSTOFFICE.	INDUSTRY.	H. P.
Helm's Mill	Belgreen	flour and grist mill	6
M. J. Height	Baggett	flour and grist mill	10
James McNair	Kirby	flour and grist mill	20
Andrew Posey	Igoburg	flour and grist mill	24
Thomas Watson	Phil Campbell	flour and grist mill	20
S. T. Bonds	Pleasant Site	flour and grist mill	80
Jes. S. Scott	Russellville	flour and grist mill	10
Sparks Mill	Underwood	flour and grist mill	10
John T. McAlister	Phil Campbell	lumber and timber mill	10

*GENEVA COUNTY.

NAME.	POSTOFFICE.	INDUSTRY.	H. P.
Avant's Mill	Geneva	flour and grist mill	15
Lowry's Mill	Geneva	flour and grist mill	10
Bell's Mill	Fadette	flour and grist mill	15
W. J. Keith and R. Y. Daniels	Geneva	flour and grist mill	15
Clark's Grist Mill	Highnote	flour and grist mill	4
Underwood's Grist Mill	Sanders	flour and grist mill	20
Condry's Grist Mill	Whitaker	flour and grist mill	15
John T. Coleman	Geneva	lumber and timber mill	30
Clark Bros. & Co.	Wicksburg	lumber and timber mill	10
Wilson Deshoga	Dundee	lumber and timber	15
Nathan Hall	Dotham	lumber and timber	20

HALE COUNTY.

	NAME.	POSTOFFICE.	INDUSTRY.	H. P.
*	William Steward	Fivemile	flour and grist mill	8
	William A. Avery, (Five-Mile Creek)	Five-Mile	flour and grist	10
	J. H. Payne & Co.	Ingram	flour and grist mill	10
	M. M. Avery	Havanna	flour and grist mill	15
	Pickens Mill	Greensboro	lumber and timber mill	15
	Greensboro Carriage & Wagon Shops	Greensboro	carriages and wagons	6
‡	Richardsons Mills, (Five-Mile Creek)	Five-Mile	grist mill and gin	20
	J. H. Payne's Mill, (Five-Mile Creek)	Havana	grist and gin	20
	Avery's Mill, (Five-Mile Creek)	Havana	grist mill and gin	25
	J. A. Stephenson, (Prairie Creek)	Newbern	grist mill & gin	20
	Irwin & Martin, (Big Creek)	Greensboro	grist mill and gin	25

*HENRY COUNTY.

NAME.	POSTOFFICE.	INDUSTRY.	H. P.
Kennedy's Mill	Shorterville	flour and grist mill	8
Joshua A. Hart	Granger	flour and grist mill	15
Jeffcoat Mill	Gordon	flour and grist mill	8
Blacksheer & Saunders	Haleburg	flour and grist mill	25
Cumming's Mill	Bush	flour and grist mill	20
Joe Baker	Hadland	flour and grist mill	27
Badiford Grist Mill	Little Rock	flour and grist mill	15
Blackshe & Sanders	Haleburg	flour and grist mill	15
John L. Smith	Ashford	flour and grist mill	13
Mark Shelley	Balkum	flour and grist mill	6
Singleterry's Water Mill	Kinsey	lumber and timber	27
J. P. Williams & Co.	Columbia	lumber and timber	25

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*From U. S. Census, 1900.

†From report of Probate Judge.

*JACKSON COUNTY.

NAME.	POSTOFFICE.	INDUSTRY.	H. P.
Moody's Flouring Mill	Kyles	flour and grist mill	40
George W. Brown	Kosh	flour and grist mill	8
J. F. Bell	Maxwell	flour and grist mill	4
Coffey's Mill	Scottsboro	flour and grist mill	8
Gross Mill	Parks Store	flour and grist mill	10
Hackworth's Mills	Bolivar	flour and grist mill	8
John S. Henegar	Rosalie	flour and grist mill	20
Bort Harrison	Section	flour and grist mill	6
W. A. Howell	Hollytree	flour and grist mill	5
Mathew's Grist Mill	Carns	flour and grist mill	10
Page's Mill	Woodville	flour and grist mill	6
Paint Rock Milling Co.	Paint Rock	flour and grist mill	8
Reid & Prince	Estillfork	flour and grist mill	20
David H. Starkey	Kosh	flour and grist mill	8
Shork Mills	Hollywood	flour and grist mill	60
Cagle Mill	Oakley	flour and grist mill	12
John Thomas	Pisgah	flour and grist mill	20
Martin Walker	Trenton	flour and grist mill	40
James P. Williams	Trenton	flour and grist mill	20
John V. Wheeler	Pisgah	flour and grist mill	20
Charles W. Brown	Glenzaida	lumber and timber mill	25
J. N. Gonce	Anderson	lumber and timber mill	20
Melton Morris	Daugherty	lumber and timber mill	12
David M. Starkey	Kosh	lumber and timber mill	20
Tomon Shingle Mill	Culver	lumber and timber mill	10

*JEFFERSON C6OUNTY.

NAME.	POSTOFFICE.	INDUSTRY.	H. P.
J. M. Landrum	Pinson	flour and grist mill	20
John Lowery Mill	Gary	flour and grist mill	12
Hendon's Corn Mill	Trussville	flour and grist mill	10
Posey's Mill	Morris	flour and grist mill	20
James W. Raney	Ezra	flour and grist mill	35
William B. Rogers	Toadvine	flour and grist mill	32
G. W. Underwood	Argo	flour and grist mill	15
William J. Wedgworth	Cardiff	flour and grist mill	10
W. W. Woodruff	Adamsville	flour and grist mill	8
W. M. Self	Oneonto	flour and grist mill	15
William M. Phillip	Greene	flour and grist mill	40
Hurst & Johnson	Pinson	lumber and timber mill	18
James W. Raney	Ezra	woolen goods	35

LAMAR COUNTY.

	NAME.	POSTOFFICE.	INDUSTRY.	H. P.
*	John H. Cantrell	Pharos	flour and grist mill	15
	Claborn E. Carter	Detroit	flour and grist mill	12
	Kirk's Mill, (Yellow Creek)	Sizemore	flour and grist mill	8
	Mote's Mill, (Beaver Creek)	Guin	flour and grist mill	6
	John T. Moore, (Yellow Creek)	Vernon	flour and grist mill	35
	H. W. Miller, (Luxapelila Creek)	Millport	flour and grist mill	20
	Stanford Mills	Detroit	flour and grist mills	12
	S. B. Thomas	Arcola	flour and grist mills	10
	Lafayette J. Hayes	Molloy	lumber and timber mill	15
	Hiram Hollis	Vernon	lumber and timber mill	35
	Dr. Wm. H. Kennedy	Kennedy	lumber and timber mill	50
	S. B. Thomas	Arcola	lumber and timber mill	15

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*From U. S. Census, 1900.

	NAME. POSTOFFICE. INDUSTRY.	H. P.
†	J. O. Kennedy, Kennedy, mill and gin	
	J. W. Thomas, Jr., (Hills Creek), Alfred, gin, saw and grist	
	W. M. Thomas, (Hills Creek), Alfred, gin, saw and grist mill	
	Osborn & Hill, (Yellow Creek), Blowhorn, gin, saw and grist	
	D. M. Hollis, (Beaver Creek), Beaverton, gin, saw and grist	
	B. G. Boman, (Yellow Creek), Vernon, gin, saw and grist mill	
	A. A. Mathews, (Yellow Creek), Arcola, gin, saw and grist mill	
	W. L. Morton, (Yellow Creek), Vernon, gin, saw and grist mill	
	Penning Bros., Baxter, gin, saw and grist mill	

*LAUDERDALE COUNTY.

NAME. POSTOFFICE. INDUSTRY.	H. P.
William M. Thornton, Rogersville, flour an grist mill	20
James A. Bevis, Threet, flour and grist mill	8
Jessie J. Bevis, Kendell, flour and grist mill	6
George M. Bretherick, Hines, flour and grist mill	24
Isa B. Eastep, Eastep, flour and grist mill	8
Ingram Brothers, Anderson, flour and grist mill	8
Thomas D. Pruitt, Pruitton, flour and grist mill	24
Sharpe's Mill, Florence, flour and grist mill	40
Nancy Williams, Lexington, flour and grist mill	20
H. N. Call, Reserve, flour and grist mill	18
Chandler & Chittam, Oliver, flour and grist mill	20

LAWRENCE COUNTY.

	NAME. POSTOFFICE. INDUSTRY.	H. P.
*	Burrell & Casteel, Progress, flour and grist mill	10
	George's Mill, Leighton, flour and grist mill	18
	Jones' Estate, Kinlock, flour and grist mill	10
	Kerby's Mill, Avoca, flour and grist mill	16
	Thomas Oliver, Hatton, flour and grist mill	16
	John S .Stephenson & Co., Kinlock, flour and grist mill	27
	Wesley L. Stover, Crow, flour and grist mill	15
	Terry & Terry, Courtland, flour and grist mill	20
	Wallace Mill, Avoca, flour and grist mill	10
	W. M. Willingham, Camp Spring, lumber and timber mill	1
†	H. C. McClannaher, (Town Creek), Mount Hope, grist mill	
	John S. Stephenson, (Sipsey River,) Moulton, flour and grist	
	Ben F. Masterson, (Big Nance Creek), Moulton, grist mill	
	W. G. Hamilton, (Big Nance Creek), Pitt, grist mill	
	J. M. Key, (Brushey Creek), Pool, grist mill	
	W. L. Stover, (Flint Creek), Oakville, flour and grist mill	
	B. A. Casteel, (Flint Creek), Sewickley, flour and grist mill	

LEE COUNTY.

	NAME. POSTOFFICE. INDUSTRY.	H. P.
*	Shelton's Mill, Opelika, flour and grist mill	40
	Floyd Mill, Opelika, flour and grist mill	10
	George W. McKinnon, Yale, flour and grist mill	24
	Vaugh Mill, Loachapoka, flour and grist mill	20
	N. G. Macon, (Reed Creek), Loachapoka, flour and grist mill	30
	W. O. Moore, Auburn, flour and grist mill	40
	W. K. Meadows, (Halawochee Cr.), Hattie, flour and grist mill	36
	James Crosby, Osanippa, flour and grist mill	15
	Benjamin F. Stripling, Yale, lumber and timber	20
†	W. W. Wright, (Chewacla Creek), Auburn, not in use now	
	W. W. Wright & Geo. P. Harrison, Opelika, (Saugahatchee Cr.)	
	H. J. Spratling, (Frazer Creek), Opelika, grist mill	25
	B. F. Meadows, (Halawochee Creek), Opelika, grist mill	40

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*From U. S. Census, 1900.
†From report of Probate Judge.

LIMESTONE COUNTY.

	NAME.	POSTOFFICE.	INDUSTRY.	H. P.
*	Weatherford Bros.	Elkmont	flour and grist mill	6
	Carter's Mill	Athens	flour and grist mill	16
	Dupree & Stepp	Mount Rozell	flour and grist mill	25
	Haye's Grist Mill	Mooresville	flour and grist mill	15
	T. M. Holmes	Elkmont	flour and girst mill	12
	John M. Head	Pettusville	flour and grist mill	8
	Nancy Haney	Legg	flour and grist mill	20
	Edward G. Hampleton	Goodsprings	flour and grist mill	15
	Thomas D. Hastings	Elkmont	flour and grist mill	5
	James L. Lamar	Goodsprings	flour and grist mill	8
	Eugene Parham, (Piney Creek)	Athens	flour and grist mill	8
	M. A. Phillips	Shoalford	flour and grist mill	12
	Ripley's Mill	Ripley	flour and grist mill	15
	George Vassar	Lax	flour and grist mill	8
	Witty's Mill, (Birds Branch)	Athens	flour and grist mill	15
	William J. Woodfin	Pettusville	flour and grist mill	15
	Pioneer Mill	Mount Rozell	flour and grist mill	20
	A. P. Andrews	Elkmont	flour and grist mill	8
	William N. Webb	Elkriver Mills	flour and grist mill	12
	Baker's Mills	Elkriver Mills	flour and grist mill	8
	Allison Miller	Rowland	flour and grist mill	10
	Grisham Bros.	Elkriver Mills	lumber and timber	40
	Grisham Bros.	Elkriver Mills	carriages and wagons	40
†	L. C. Hightower, (Big Creek)	Elkriver Mills	saw, flour and grist mill	
	Wm. Bailey, (Big Creek)	Quidnunc	flour and grist mill	
	J. W. Carter, (Big Creek)	O'Neal	gin, flour and grist mill	
	M. J. Witty, (Birds Branch)	Athens	flour and grist mill	
	J. C. Vaughn, (Sulphur Creek)	Elkmont	gin, flour & grist mill	
	R. B. Malone, (Sulphur Creek)	Athens	gin, flour and grist mill	
	Wm. Woodfin, (Ragsdale Creek)	Elkmont	gin, flour and grist	
	J. W. Carter, (Panther Creek)	Carter	gin, flour and grist mill	
	John Carroll, (Leslie Creek)	Centerhill	gin, flour and grist mill	
	Wm. Davidson, (Limestone Creek)	Lax	gin, flour and grist mill	
	R. M. Clem, (Piney Creek)	Fairmount	gin, flour and grist mill	
	Eugene Parkam, (Piney Creek)	Athens	gin, flour and grist mill	
	W. M. Hayes, (Limestone Cr.)	Mooresville	gin, flour and grist	
	W. H. Roberts, (Sugar Creek)	Athens	gin, flour and grist mill	
	W. H. Marbut	Goodsprings	gin, flour and grist mill	

LOWNDES COUNTY.

NAME.	POSTOFFICE.	INDUSTRY.	H. P.
*G. B. Holley	Lowndesboro	flour and grist mill	10
†W. N. Bozeman	Benton	gin and mill	

*MADISON COUNTY.

NAME.	POSTOFFICE.	INDUSTRY.	H. P.
Fannie J. Ridley	Haden	flour and grist mill	8
D. L. Middleton Water Mill	Gurley	flour and grist mill	20
Delop's Mill	Dan	flour and grist mill	8
Hardy Keel Water Mill	Gurley	flour and grist mill	15
Annie M. Taylor	Hazelgreen	flour and grist mill	8
Bellfactory Mill	Huntsville	flour and grist mill	25
Key's Mill	Keysmill	flour and grist mill	28
William S. Russell	Madison Station	flour and grist mill	12
Chas. F. Rountree	Maysville	flour and grist mill	15
William S. Garvin	Monrovia	flour and grist mill	15
A. D. and W. E. Rogers	Newmarket	flour and grist mill	60
Butler Mill Co.	Poplarridge	flour and grist mill	30
Payne & Miller	Huntsville	flour and grist mill	30
Martin's Grist Mill	Huntsville	flour and grist mill	15
H. C. Turner	Dan	lumber and timber	16
Daily Mercury	Huntsville	printing and publishing	6

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*From U. S. Census, 1900.

†From report of Probate Judge.

*MACON COUNTY.

NAME. POSTOFFICE. INDUSTRY.	H. P.
H. H. Robinson, Loachapoka, flour and grist mill	4
M. W. Glass, Societyhill, flour and grist mill	8
J. O. H. Perry, Tuskegee, flour and grist mill	20

MARION COUNTY.

	The Carter Mill, Ur, flour and grist mill	5
	Bexar Mercantile Co., Bexar, flour and grist mill	8
	Eads & Fowler, Glenallen, flour and grist mill	12
	The Boatwright Mill, Inez, flour and grist mill	12
	Samuel A. & Wm. V. Read, Eldridge, flour and grist mill	20
	Jasper N. Green & Sons, Brilliant, flour and grist mill	20
	Elishu Vickery, Winfield, flour and grist mill	16
*	The Shirley Mill, Ur, flour and grist mill	10
	Jesse G. Poe, Bearcreek, flour and grist mill	6
	Bull, Atkins & Donaldson, Haleysville, flour and grist mill	52
	Buttahatchee Mill Co., Haleysville, lumber and timber	52
	John Cumens, Haleysville, lumber and timber	12
	Kelly Saw Mill, Haleysville, lumber and timber	15
	John R. Phillips, Bearcreek, lumber and timber	50
	Simon W. Moss, Winfield, lumber and timber	36
	The Powell Mill & Wool Carder, Duffey, woolen goods	50
	Albert J. Hamilton, (Williams Creek), Hamilton, flour and grist	
	W. C. Gann, (Sipsey Creek), Bexar, flour and grist mill	
	Q. Northington, (Sipsey Creek), Hamilton, flour and grist mill	
	Crane & Riggs, (Sipsey Creek), Delhi, flour and grist mill	
	T. L. Shotts, (Bull Mountain Creek), Shottsville, flour and grist	
	I. J. Loyd, (Bull Mountain Creek), Bull Mountain, flour and grist	
	D. F. Ballard, (Williams Creek), Hamilton, flour and grist mill	
†	James P. Pearce, (Buttahatchee River), Pearce's Mill, flour and grist mill	
	James P. Pearce, (New River), Texas, flour and grist mill	
	J. C. Carter, (Woods Creek), Elmira, flour and grist mill	
	James Young, (Cantrell Mill Creek), Hamilton, flour and grist	
	W. J. Wright, (Barnesville Mill Creek), Barnesville, flour and grist mill	
	Henry Guin, Guin, flour and grist mill	
	Tucker Moss, (Luxapelila Creek), Winfield, flour and grist mill	
	D. G. Morrow, (Woods Creek), Elmira, flour and grist mill	

*MARSHALL COUNTY.

J. M. Ellison, Preston, flour and grist mill	4
Mathis Mill, Albertville, flour and grist mill	10
James B. Powell, Columbus City, flour and grist mill	4
James F. Prentice, Arab, flour and grist mill	7
P. C. Ragsdale, Uniongrove, flour and grist mill	10
James P. Smith, Warrenton, flour and grist mill	10
Scott's Mill, Friendship, flour and grist mill	8
John D. Sumers, Boaz, flour and grist mill	15
Lakey Mill, Bartlett, flour and grist mill	10
George E. Whisnant & Son, Oleander, flour and grist mill	10
I. G. Gross, Columbus City, flour and grist mill	12
Walker & Fowler Mills, Friendship, flour and grist mill	20
William J. Copelan, Diamond, flour and grist mill	5
James Wm. Barclay, Woodville, flour and grist mill	10
The Winston Mill, Meltonsville, flour and grist mill	12
W. G. Smith Estate, Sidney, flour and grist mill	10
Jas. M. Selvage, Grant, flour and grist mill	4

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*From U. S. Census, 1900.

†From report *of Probate* Judge.

MARENGO COUNTY

	NAME.	POSTOFFICE.	INDUSTRY.	H. P.
	*Rhodes Mill	Sweetwater	flour and grist mill	12
	*MOBILE COUNTY.			
	N. Q. Thompson	Citronelle	flour and grist mill	10
	H. Brannan & Son	Pierce	lumber and timber	30
	T. A. Hatter & Son	Creola	lumber and timber	75
	Littleton Lee	Pierce	lumber and timber	60
	*MONROE COUNTY.			
	J. B. Solomon	Manistree	flour and grist mill	15
	James H. Simpson	Mexia	flour and grist mill	10
	Benjamin Johnson	Hollinger	flour and grist mill	15
	Andrew Bohanon	Franklin	flour and grist mill	15
	David J. Hatter & Son	Wait	lumber and timber	60
	David J. Hatter & Son	Wait	lumber and timber	20
	C. C. Yarbrough	Monroeville	lumber and timber	20
	*MONTGOMERY COUNTY.			
	Daniel's Mill	Sellers	flour and grist mill	25
	Montgomery Cotton Mill	Montgomery	cotton goods	35
	MORGAN COUNTY.			
	*Sarah M. McCutcheon	Briscoe	flour and grist mill	10
	PERRY COUNTY.			
*	Henry C. Nichols, (Dobynes Creek)	Theo	flour and grist mill	20
	Mary G. Wallace	Marion	flour and grist mill	4
	Hodger's Mill	Newbern	flour and grist mill	15
	W. F. Moore	Marion	flour and grist mill	4
	Downey's Saw Mill	Greensboro	lumber and timber	15
	Stevenson's Saw & Water Mills	Newbern	lumber and timber	20
	Lucindy Washburn, (Taylor Creek)	Jericho	lumber and timber	18
†	W. T. Downey, (Limestone Creek)	Folsom	grist mill	6
	James Wallace, (Legroane Creek)	Jericho	grist mill	8
	Dr. J. B. Tucker, (Taylors Creek)	Jericho	grist mill	6
	Lucindy Washburn, (Taylors Creek)	Jericho	grist mill	8
	S. M. Bolling, (Branch of Oakmulgee Cr.)	Pinetucky	grist mill	8
	C. C. Cosby, (Oakmulgee Creek)	Perryville	grist mill	8
	Thomas J. Fountain, (Little Creek)	Oakmulgee	gin, saw and grist mill	8
	Pann Patterson, (Little Creek)	Oakmulgee	gin, saw and grist	8
	Sarah Fountain, (Little Creek)	Oakmulgee	gin, saw and grist	8
	Thaddeus Smith, (Little Creek)	Active	grist mill	8
	W. M. Eiland, (Fords Mill Creek)	Marion	grist mill	20
	J. F. Morton, (Potato Patch Creek)	Levert	grist mill	6
	Elijah Smith, (Beaver Creek)	Bliss	grist mill	6
	Noah Coker, (Beaver Dam Creek)	Bethlehem	grist mill	6
	W. A. Fountain, (Oakmulgee Creek)	Oakmulgee	rice mill	10
	*PICKENS COUNTY.			
	Richardson & Prichards	Coalfire	flour and grist mill	25
	James Mullenix	Gordo	flour and grist mill	6
	H. B. & A. W. Latham	Carrollton	flour and grist mill	12
	Slaughter's Mill	Raleigh	flour and grist mill	16
	W. A. Kerr	Reform	lumber and timber	10

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*From U. S. Census, 1900.

†From report of Probate Judge.

*PIKE COUNTY.

NAME.	POSTOFFICE.	INDUSTRY.	H. P.
M. J. Youngblood	Youngblood	flour and grist mill	110
William F. Ingram	Josie	flour and grist mill	20
Nancy Cotton, (Cotton's Mill)	Milo	flour and grist mill	12
Ely Dees & J. D. Murphee	Pronto	flour and grist mill	20
George W. King	Gosnen	flour and grist mill	30
The Lewis Mill	Rodney	flour and grist mill	24
McQuaggis Mill	Ansley	flour and grist mill	15
George F. Williams	Tatum	flour and grist mill	4
Slatting's Grist Mill	Henderson	flour and grist mill	25
P. A. Motia	Wingard	flour and grist mill	8
Bowden & Daughtry	Tennille	flour and grist mill	16
William E. Brown	Josie	flour and grist mill	10
G. B. Howard	Goshen	flour and grist mill	20

*RANDOLPH COUNTY.

W. W. Dobson	Wedowee	flour and grist mill	20
J. H. White & Z. N. Lipham	Clack	flour and grist mill	11
Mrs. Georgia Gibbs	Wedowee	flour and grist mill	10
Gilis Mill	Ofelia	flour and grist mill	10
Eppie M. White	Bernice	flour and grist mill	5
Larkin & M. B. Taylor	Lamar	flour and grist mill	8
Joseph B. Taylor	Roanoke	flour and grist mill	24
Owins Mill	Potash	flour and grist mill	15
Rogers Mill	Ofelia	flour and grist mill	8
C. A. Prescott	Wedowee	flour and grist mill	20
H. A. Merrill	Lamar	flour and grist mill	6
Elizabeth H. Merrill	Micaville	flour and grist mill	12
J. E. McCosh & Co.	Lime	flour and grist mill	40
William S. McCarley	Graham	flour and grist mill	20
John H. Landers	Lofty	flour and grist mill	8
Edward Lavoorn	———	flour and grist mill	8
Thomas J. Lavoorn	Hawk	flour and grist mill	16
Thomas J. Lavoorn, Sr.	Newell	flour and grist mill	8
James L. & John T. Kaylor	Kaylor	flour and grist mill	60
Henry C. Jordon	Clack	flour and grist mill	6
J. B. Hammond	Sewell	flour and grist mill	8
T. M. Halaway	Tolbut	flour and grist mill	15
Robert H. Harris	Louina	flour and grist mill	15
Dock Huckaby	Almond	flour and grist mill	10
Holley's Mill	Rock Mills	flour and grist mill	30
E. C. Heaton	Hawk	flour and grist mill	10
William N. Gladney	Roanoke	flour and grist mill	12
A. B. East	Christiana	flour and grist mill	2
Adamson & Edward's Mills	Ofelia	flour and grist mill	25
Bailey Mill	Haywood	flour and grist mill	12
F. P. Parker	Foresters Chapel	flour and grist mill	10
John C. Murphy	Gay	flour and grist mill	2
E. L. Pool	Happyland	flour and grist mill	20
James M. Kitchens	Rockdale	flour and grist mill	8
James H. Wright	Jeptha	flour and grist mill	12
Adamson & Edwards	Ofelia	lumber and timber	40
William W. Brooks	Lofty	lumber and timber	15
William A. Camp	Almond	lumber and timber	10
James L. & John T. Kaylor	Kaylor	lumber and timber	20
H. H. Stephens	Pencil	lumber and timber	20
Samuel H. Striplin	Roanoke	leather, tanned, curried & finished	6
Wehadkee Cotton Mills	Rock Mills	cotton goods	108

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*From U. S. Census, 1900.

RUSSELL COUNTY.

	NAME.	POSTOFFICE.	INDUSTRY.	H. P.
*	Davis' Mill	Crawford	flour and grist mill	20
*	H. R. Dudley	Seale	lumber and timber	40
	†E. M. Anderson, (Watermelon Cr.)	Seale	grist mill and gin	20

*SHELBY COUNTY.

NAME.	POSTOFFICE.	INDUSTRY.	H. P.
W. C. Denson	Pelham	flour and grist mill	12
William H. Shrader	Shelby	flour and grist mill	20
William H. Pledger	Pelham	flour and grist mill	40
Hendrick & Alverson	Vincent	flour and grist mill	40
David A. Whitfield	Vandiver	flour and grist mill	10
Brownings Mill	Columbiana	lumber and timber	30

*ST. CLAIR COUNTY.

NAME.	POSTOFFICE.	INDUSTRY.	H. P.
The Yarbrough Mill	Ashville	flour and grist mill	8
Hare's Mill	Ashville	flour and grist mill	8
John R. Dyke	Wolfcreek	flour and grist mill	30
Perry E. Wyatt	Coal City	flour and grist mill	10
Henry A. Palmer	Partlow	flour and grist mill	10
J. M. McLaughlin	Springville	flour and grist mill	25
The Machen Mill	Partlow	flour and grist mill	10
The Lindsey Mill	Ashville	flour and grist mill	10
Hill & Foreman	Springville	flour and grist mill	28
Henderson's Mill	Ragland	flour and grist mill	5
Helm & Truss	Helms	flour and grist mill	20
Grout's Mills	Wolfcreek	flour and grist mill	10
The Gilchrist Mill	Ashville	flour and grist mill	5
The Cox Mill	Ashville	flour and grist mill	10
Rufus W. Beason	Whitney	flour and grist mill	11
Rock Bridge Mill	Gallant	lumber and timber mill	20

*SUMTER COUNTY.

NAME.	POSTOFFICE.	INDUSTRY.	H. P.
E. B. Hearn, (Kinterbish Creek)	Gaston		40
R. H. Stephens, (Kinterbish Creek)	Alamuchee		20
R. D. Simmons, (Toomsooba Creek)	Bell's Station		30
R. W. Shaw	Cuba		10
W. H. Walker, (Silver Creek)	Alamuchee		20
J. U. Gillespie, (Coatopa Creek)	Coatopa		10

TALLADEGA COUNTY.

	NAME.	POSTOFFICE.	INDUSTRY.	H. P.
*	Jefferson Roberson	Fayetteville	flour and grist mill	10
*	J. C. Brock	Eastaboga	flour and grist mill	12
*	Riser & Bro.	Talladega	flour and grist mill	40
*	Shock E. Jemison	Sunnyside	flour and grist mill	15
*	Vincent Mill	Talladega	flour and grist mill	25
*	O. F. Luttrell	Talladega	flour and grist mill	40
*	Riddle Mills	Waldo	flour and grist mill	16
*	J. F. Smith	Eastaboga	flour and grist mill	40
*	John W. Thweatt	McFall	flour and grist mill	12
*	J. B. Turner	McFall	flour and grist mill	15
*	Allison's Mill	Talladega	flour and grist mill	60
*	J. F. Smith	Eastaboga	lumber and timber	40
*	Cragdale Mill	Talladega	lumber and timber	40
*	J. B. Turner	McFall	lumber and timber	20

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*From U. S. Census, 1900.
†From report of Probate Judge.

	NAME.	POSTOFFICE.	INDUSTRY.	H. P.
	Priebes Mill, (Choccolocco Creek)	Jenifer	grist mill	200
	J. F. Smith's Mill, (Choccolocco Creek)	Oxford	grist mill	225
	B. Schmidt's Mill, (Choccolocco Creek)	Lincoln	grist mill	200
	Craig's Mill, (Choccolocco Creek)	Oxford	grist mill	150
	Wilson's Mill, (Choccolocco Creek)	Jenifer	grist mill	150
	Eureka Mills, (Choccolocco Creek)	Eureka	grist mill	150
	Turner's Mill, (Chehawhaw Creek)	McFall	grist mill	150
	Kants Mill, (Talladega Creek)	Chandler Springs	grist mill	50
	Riddle's Mill, (Talladega Creek)	Waldo	grist mill	75
	Taylor's Mill, (Talladega Creek)	Talladega	grist mill	150
†	Reynold's Mill, (Talladega Creek)	Nottingham	grist mill	150
	Allison's Mill, (Talladega Creek)	Talladega	grist mill	75
	Duncan's Mill, (Talladega Creek)	Alpine	grist mill	75
	Baker's Mill, (Talladega Creek)	Kymulga	grist mill	100
	Vincent's Mill, (Crooked Creek)	Sylacauga	grist mill	50
	Oden's Mill, (Short Creek)	Sylacauga	grist mill	75
	Jemison's Mill, (Kelley's Creek)	Sunnyside	grist mill	50
	Camp & Sons' Mill, (Salt Creek)	Hopeful	grist mill	50
	Robinson's Mill, (Cedar Creek)	Fayetteville	grist mill	50
	Lackey's Mill, (Horse Creek)	Ironaton	grist mill	25
	Talladega Company, (Choccolocco Creek)	Talladega	organized for electric transmission	

*TALLAPOOSA COUNTY.

NAME.	POSTOFFICE.	INDUSTRY.	H. P.
George Stewart	Thaddeus	flour and grist mill	12
John W. Britt	Jacksons Gap	flour and grist mill	20
Benjamin F. Jarvis	Yates	flour and grist mill	12
T. J. Hamlet	Hamlet	flour and grist mill	15
T. W. Whitman	Dadeville	flour and grist mill	20
Sanford Milling & Mfg. Co.	Dadeville	flour and grist mill	25
John W. Hay	Camphill	flour and grist mill	15
Hammond's Mill	Dadeville	flour and grist mill	20
Hodnett Grist & Flour Mill	Acme	flour and grist mill	16
Thomas L. Bulger	Dadeville	flour and grist mill	15
Vines Mills	Easton	flour and grist mill	40
A. T. & H. C. Vickers	Newsite	flour and grist mill	20
J. C. Street	Anniston	flour and grist mill	25
Shephard Bros. & Co.	Tohopeka	flour and grist mill	10
G. W. Stewart	Thaddeus	flour and grist mill	25
Albert J. Hollaway	Alexander City	flour and grist mill	20
Mrs. Milliner	Mary	flour and grist mill	25
Jno. L. Patterson	Hackneyville	flour and grist mill	12
Thomas B. Griffin	Matilda	flour and grist mill	10
Daviston Mill	Daviston	flour and grist mill	8
Lamberth & Dewberry	Logpit	flour and grist mill	20
Silver Shoals Mill	Buttston	flour and grist mill	80
M. R. Hays & Bro.	Notasulga	flour and grist mill	40
Farrows Flour & Grist Mill	Susanna	flour and grist mill	60
J. H. Yarbrough	Hackneyville	flour and grist mill	12
T. F. Garnett	Tallassee	lumber and timber	20
G. W. Stewart	Thaddeus	lumber and timber	20

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*From U. S. Census, 1900.

†From report of Probate Judge.

*TUSCALOOSA COUNTY.

NAME.	POSTOFFICE.	INDUSTRY.	H. P.
Price's Mill	Binion	flour and grist mill	8
Keene's Mill	Cottondale	flour and grist mill	20
B. E. Thompson	Cottondale	flour and grist mill	15
Wm. D. Shadix, (Sandy Creek)	Double Springs	flour and grist	4
J. W. Spencer	Elrod	flour and grist mill	10
Webb's Mill	Elrod	flour and grist mill	20
Hagler's Mill	Falls	flour and grist mill	40
Patton's Mill	Fosters	flour and grist mill	12
David M. Montgomery	Moores Bridge	flour and grist mill	10
Looney John Mills	New Lexington	flour and grist mill	6
Eitson's Mill	New Lexington	flour and grist mill	12
Alfred Gilliland	Newtonvile	flour and grist mill	12
Andrew J. Hewett	Skelton	flour and grist mill	5
Tierce's Mill	Tierce	flour and grist mill	10
James M. Yerby	Tuscaloosa	flour and grist mill	20
O. W. Glenn	Tyner	flour and grist mill	8
The Rope & Yarn Mills, (Binion's Creek)	Samantha	cordage and twine	60

*WALKER COUNTY.

NAME.	POSTOFFICE.	INDUSTRY.	H. P.
Boldo Grist Mill	Boldo	flour and grist mill	40
James B. Wakefield	Prospect	flour and grist mill	10
Lewis W. Odom	Oakman	flour and grist mill	10
Mahala E. & Dalton Odom	Parrish	flour and grist mill	10
Joseph Z. Norris	Galloway	flour and grist mill	5
Thomas J. King	Oakman	flour and grist mill	10
Lewis Guthrie	Pocahontas	flour and grist mill	10
Wm. Cobb	Oakman	flour and grist mill	10
Peter McGough	Carbonhill	lumber and timber	10

*WASHINGTON COUNTY.

NAME.	POSTOFFICE.	INDUSTRY.	H. P.
Mrs. Samuel Wilkins	Healing Springs	flour and grist mill	6
Consey's Mill	Healing Springs	lumber and timber mill	10

WILCOX COUNTY.

	NAME.	POSTOFFICE.	INDUSTRY.	H. P.
*	Ward & Grimes, (Pine Barren Creek)	Pineapple	flour and grist	33
	George A. Barge	Snowhill	flour and grist mill	15
	J. W. Cooper	Candler	flour and grist mill	16
†	George Barge, (Pine Barren Creek)	Furman	grist mill and gin	
	Glover & Carter, (Pine Barren Cr.)	Pineapple	grist mill and gin	
	S. McCormick, (Pine Barren Cr.)	Pineapple	grist mill and gin	
	D. McIntosh, (Pursley Creek)	Camden	grist mill and gin	

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*From U. S. Census, 1900.

†From report of Probate Judge.

WINSTON COUNTY.

	NAME	POSTOFFICE.	INDUSTRY.	H. P.
*	Richard H. Blake	Houston	flour and grist mill	8
	Thomas O. Partridge	Elk	flour and grist mill	10
	Wm. D. Shadix, (Sandy Creek)	Double Springs)	flour and grist	4
	George D. Wilson	Haleysville	flour and grist mill	8
	Manna A. Posey	Motes	flour and grist mill	10
	Martin A. & Martha Peak	Peaks Mill	flour and grist mill	10
	Miligan Mill	Double Springs	flour and grist mill	10
	James Cantrell	Addison	flour and grist mill	4
	Burks Mill	Cranal	flour and grist mill	10
†	Nauvoo Mill, (Black Water Creek)	Nauvoo	grist mill and gin	
	Anderson Ward Mill, (Clear Creek)	Haleysville	flour and grist	
	J. Calvin Cagle, (Clear Creek)	Double Springs	saw, flour and grist mill and gin	
	Jonathan Barton Mill, (Clear Creek)	Deer	grist mill	
	Hadder Mill, (Clear Creek)	Double Springs	grist mill	
	Posey Mill, (Clear Creek)	Motes	grist mill, saw and gin	
	S. D. Spain, (Clear Creek)	Malta	grist mill, saw and gin	
	Gus Posey Mill, (Clear Creek)	Elk	grist mill, saw and gin	
	Wm. Dodd, (Splunge Creek)	Natural Bridge	grist mill, saw and gin	
	Kelley Mill, (Black Water Creek)	Lynn	grist mill, saw and gin	
	Peaks Mill, (Grindstone Creek)	Peaks Mill	grist mill, saw and gin	
	Jack Curtis, (Sandy Creek)	Double Springs	grist mill, saw and gin	
	Manley Payne, (Beech Creek)	Gumpond	grist mill, saw and gin	
	Christian Mill, (Christian Creek)	Peaks Mill	grist mill, saw	

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*From U. S. Census, 1900.

†From report of Probate Judge.